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Consumer acceptance of Blockchain-Based Traceability Systems in Food Supply Chains

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ABSTRACT

The demand for the history of food is increasing. The used food traceability systems also provide this kind of information, but the appearance of blockchain could open new opportunities in this field. To set up a new food tracking system cost a lot and presumably the companies devolution it's costs on the consumers. To see their openness we examined the previous studies. According to these papers, the interest of the costumers is mixed. There are studies where a huge percentage of the surveyed want more information but the extra fee what the new system would cause should be not so much higher than the original price. Based on the available information the forecast of a new food tracking system was made with Anylogic simulation software that showed a lack of interest from the consumers' side. The reason could be the low rate of the advertisements' effectiveness and the high premium price of extra information as well.

1. Introduction

There are religious or health reasons that make it essential to know the full history of food. Behind this new demand, there is information asymmetry. While product labels provide consumers information, thereby reducing information asymmetry, food traceability systems could be the real solution, as they can monitor the entire food production process and thus provide a reliable and continuous flow of information. This method will not only meet the specific needs of some consumers but will also reduce food safety risks. According to global economic and technological changes, increasing of information systems development, companies have to adapt to these changes (Lutfi Al-Dalahmeh & Dajnoki,2020) however, the introduction and practical application of new (technological) solutions is a significant challenge, both on the manufacturers' and consumers' side. To build a blockchain-based traceability system that meets these consumer demands costs money which is likely to be covered from the extra price of the product, however, it is not clear how many percentages of the consumer are ready to pay for the extra information. That is why it worth measuring the openness and interest of the consumers towards this system and its extra fee.

2. Literature review

Over the past decade, Supply Chain Management (SCM) has undergone significant changes due to the rapid pace of globalization and technological development (Botos et al., 2018). Competitive pressure has forced companies to step up cooperation with their partners throughout the life cycle of the supply chain. To increase their ability to integrate processes in businesses need to face shorter

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product cycles, outsourcing and growing market demand for mass customization. As a result, companies need to create demand-driven and flexible supply chains that can meet customer expectations, thereby integrating key business processes across the supply chain while sharing their strategy for mutual benefit (Madenas et al., 2014).

Already in the early 2000s, it was clear that SCM depends on the flow of information as it enables collaboration and development between companies (Power & Bahri, 2005; Pereire, 2009; Vickery et al., 2003). By allowing product manufacturers (a product manufacturer makes its products from purchased parts of other companies) to focus on their core business while utilizing the additional resources, capabilities, and skills of their suppliers to produce lower-cost, higher-quality products, can improve through information flow between suppliers (Lindquist et al., 2008).

One useful tool for this the Vendor-Managed Inventory (VMI), which is a well-known and widely used supply chain practice between a supplier and a customer, where the supplier manages the inventory at the customer and decides when and how much to ship (Lee et al., 2016). Applying this practice helps, among other things, to reduce orders, inventory, and shipping costs (Mateen& Chatterjee, 2015).

Similar returns are provided by the “Collaborative Planning, Forecasting, and Replenishment” systems (CPFR), which are an important business process for managing demand uncertainty, point of sale data, and promotional and replenishment plans. By applying them, companies can not only reduce inventory, cost and the lead time, but also increase forecast accuracy, customer service efficiency, and sales volume (Singhry & Abd, 2018).

Here belongs also to the so-called Efficient Consumer Response (ECR), which is a model of cooperation between manufacturers and retailers in the daily consumer goods market. In implementing this strategy, grocery stores and retailers work closely together to deliver better value to the consumer (Martens & Dooley, 2010).

The flow of information between companies has been further enhanced by the development of technology and the Internet. These enabled that the development of Internet-based systems can improve collaboration within the supply chain, which is extremely important in the manufacturing industry, while in this field various digital systems are used daily to design, develop, produce, supply, and support products. This has resulted in the so-called "isolated of information islands", which means that information is stored in different systems, repositories that are not or only partially connected, although some of these systems support dynamic and direct data exchange (Fiala, 2005). Connecting these areas can be greatly helped by Industry 4.0's flagship Internet of Things (IoT). This is one of the areas most likely to be transformed by new blockchain technology. IoT sensors, Radio Frequency Identification Tags (RFID), barcodes, GPS tags, and chips allow us to accurately and continuously track the location of products, packages, and shipments. This provides improved real-time tracking of goods (Kshetri, 2018), which can lead to the inevitable evolution of the IoT’s closely linked supply chain (Casey & Wong, 2017; Srai & Lorentz, 2019). Experts of supply chain and logistics also expect that further digitalization will lead to lower costs and increased revenue (Kersten et al., 2017).

The processing industry can also be positively affected by further digitalization as it generates huge amounts of data by using various sensors (Oláh et al., 2019), electronic devices and digital machines on production lines (Zhong et al., 2015), so it is not surprising that this industry produces the most data (Nedelcu, 2013). IDC (International Data Corporation) reports that manufacturers increasingly look at this large amount of data as a great opportunity. With the analysis of it (Big Data analytics), they want to increase their competitiveness and thus their long-term profitability (Zhong et al., 2016).

However, when product manufacturers share their information and knowledge with their suppliers to help them make strategic decisions, they endanger their competitiveness. Therefore, the level of integration into their processes and the depth of cooperation need to be determined (Kim et al., 2011). The revolution in blockchain technology, which is becoming more widely available and has great potential, can eliminate the threat to competitiveness with the advent of digitalization.

Blockchain technology is often referred to in the media as an epoch-making innovation. According to Schmidt and Wagner (2019), it can be similar to the Internet, if it can go through the initial difficulties and become widely used in everyday life (Babich & Hilary, 2019; Treibmaier, 2018), while the blockchain technology is transformative but still fundamental. Just as the World Wide Web has revolutionized the global exchange of information and made it accessible to everyone, the blockchain can impact on databases. It can increase the transparency and the unalterability of data (beyond company boundaries). Besides, it can also revolutionize the way transactions are made for both physical and digital products and services (Elmasri & Navathe, 2015).

The blockchain facilitates real system state determination through network computations and consensual rules, thus replacing the need for human intervention and personal trust, influencing all data sharing and data storage processes (Zhao et al., 2016).

Blockchain forecasts are quite optimistic, despite the uncertainty, and in many cases, very difficult to estimate the costs of implementation and return on investment. This is illustrated in Figure 1, which shows the expected growth of the global role of the blockchain.

Figure 1: Global blockchain share forecast in the agriculture and food industry 2017-2028 (US $ million), own elaboration, based on statista.com

Companies expect the financial burden of introducing these technologies to be covered by the consumers, which could mean increased prices. This could influence price-sensitive consumers' decisions, so they may respond with the consumption of non-blockchain based (therefore less expensive) products. Although the willingness to pay for additional information to consumers is uncertain (Füzesi et al., 2018), and there is no completed research yet about the consumers' technology adoption, so it is not known which factors influence consumers' acceptance (Keszey & Zsukk, 2017).

2.1. The usage of blockchain in food supply chains

The globalization of markets leads to more movements not just of products but also information, and people between countries, continents. Consumers gain a lot from this development because everybody can buy fruits or vegetables in the local shops independent of the season or order „exotic products" which arrive under a few days. However, this globalization in the food sector also has disadvantages. It is more difficult to guarantee food safety because food supply chains become global (Popp et al., 2018) with a lot of actors (Behnke & Janssen, 2019). The World Health Organization estimates that 420,000 people worldwide die each year from food poisoning, while every tenth person suffers from this problem (Reshma, 2018). Not only this difficulty could be solved by the blockchain-based food traceability because it not only monitors and traces food items along the supply chain but also provides the functions of quality control and assurance as proactive food quality management (Tsang et al., 2019).

There is no one general definition of „traceability” (Bosona & Gebresenbet, 2013; Karlsen et al., 2013; Olsen & Borit, 2013), but according to Bosona and Gebresenbet (2013), the different definitions include at least two from consistency and clarity, backward follow-up of ingredients, forward follow-up of products, product history information during the supply chain. Internal traceability is the traceability capability of the internal processes of one supply chain actor, and the traceability between two actors in the supply chain is called by the Global Traceability Standard external traceability. These two traceability concepts together make the chain traceable, which means the traceability between all supply chain actors (Aung & Chang 2014). The usage of blockchain technology, by considering decentralized data management can track and trace food in a farm-to-table approach (Yung et al., 2019).

According to Galvez et al, (2018), there are three reasons why the food supply chain can benefit from the blockchain:

- Transparency. The blockchain facilitates the exchange of information, create a digital twin of the information and its workflow, and it also validates the quality of food on its way along the chain (World Economic Forum, 2017). The food on its way in the supply chain is recorded in the so-called “food bundle” blockchain object, and this is going to contain the combination of all information (quality, sustainability, flavor) at the end of the supply chain contributed by the stakeholders (Galvez et al., 2018).
- Efficiency. Every participant comes in the blockchain, where they can evaluate the assertions made, and notify their account holders when matches in timing, quality, quantity are found. Buyers and sellers also have data that is shared but trusted and it can then be combined and used by the participant. In this case, there is no need to wait for company consortiums to use standards, and/or semi-mandatory or concentrated business practices, to access the information (Galvez et al., 2018).
- Security and safe. The blockchain requires that transactions between network participants be faithfully recorded in a shared ledger. Every record has a timestamp and a unique cryptographic signature, which provides that each transaction can be traced back. Any changes in the blocks are saved in all copies within a few seconds, which prevents anyone from altering them maliciously (Zhang et al., 2018).

Although the blockchain is a decentralized ledger that acts as a database since the data is stored on networked computers, where the nodes ensure the authenticity of the data and the system as a whole - with the right licence – provides continuously available unalterable data, so the consumers with a simple (smartphone) application can immediately query the history of a product. Despite its innovations blockchain also has disadvantages that can come from technical limitations (Behnke & Janssen, 2019):

- Transaction rate. The transaction rate is limited. While the (original) blockchain was designed on a permissionless system, which limits the size of a block to max 1MB and the processing rate to seven transactions per second. Because of that hundreds of transactions, real-time processing in a short period is not possible. However, alternative variants of blockchain significantly improved the transaction rate (e.g. Eyal et al., 2016; Kogias et al., 2016).
- Immutability. The transactions which are stored in the blockchain are not just immutable but they also cannot be tampered (Zheng et al., 2017). That means the blockchain grows with each transaction and in a case when the uncontrolled number of users access it, and it can cause problems (storage); however, this is less relevant in the context of a food traceability system with a limited number of users (Behnke & Janssen, 2019).
- Protection of sensitive information. The commercial adoption of this technology depends on the level of sensitive data protection and in some cases also important the level of anonymity (Tian, 2017). The original blockchain did not include so many functions to protect sensitive information, however, the current commercial platforms not just identified this requirement but also added the possibility to control access to information in the blockchain (Hyperledger, 2018).
- Hackers. This technology depends on programming codes and the correct implementation of the technology. This software deserves well developed and maintained codes, because without them they are vulnerable, which provides hackers the opportunity to exploit (Devries, 2016).

- Standardization. Larger adoption of blockchain requires an architecture that supports more than one supply chain process and lets the actors fulfill different roles. The suppliers do not want to join to different blockchain architectures of different customers, because it would lead to fragmentation and a high level of complexity (Behnke & Janssen, 2019).

There are some companies which already use somehow the blockchain in their daily work. These companies and their branches are seen in the table below.

Table 1. Companies and their branch, which already uses blockchain technology for food traceability, own elaboration (based on Kamilaris et al, 2019.)

Turkeys	Cargill Inc. (Bunge, 2017),
Mangoes	Walmart, Kroger, IBM (CB Insights, 2017)
Pork	Walmart, Kroger, IBM (CB Insights, 2017)
Beer	Downstream (Ireland Craft Beers, 2017)
Beef	"Paddock to plate" project (Campbell, 2017), BeefLedger (BeefLedger Limited, 2017), JD.com (Adele Peter, Fast Company, 2017)
Chicken	Gogochicken (Adele Peter, Fast Company, 2017), Grass Roots Farmers Cooperative (Grass Roots Farmers' Cooperative, 2017), OriginTrail (OriginTrail, 2018)
Sea-food	WWF (WWF, 2018), Balfegó (Balfegó Group, 2017)
Organic food	Soil Association Certification (Soil Association Certification, 2018)

As it is seen in Table 1, there are many branches, where the new technology helps to track but also helps to reduce brand and reputation risk, while the end markets look for mechanisms to ensure that the products do not come from supply chains which are engaged in illegal or unethical practices (WWF, 2018).

2.2. The consumers' food tracking approach

There are a few reasons why a reliable food monitoring system is needed. Of course, the law plays an important role (EU Regulation 178/2002), but quality management aspects, logistics optimization, risk minimization also gain a lot from it (Stranieri et al., 2017), and the importance of marketing has been also increasing. In this study, we focus on the consumers' side because, in the 21st century, it becomes even more important to understand their factors that influence the adoption of the (new blockchain) technology (Keszey & Zsukk, 2017).

It is important to highlight the changed value system of consumers which is turned in a positive direction (Szakály et al., 2015), because of the health awareness the need for quality food is increased (Szakály et al., 2016). This aspect was examined in the research of Cunningham. According to his survey, 58% of participants were confident that meat products could be traced back to a processing factory within a specific herd. Not surprisingly, 74% identified traceability with quality itself, so they think the traceable meat is better in some ways. The same survey found that there was an overwhelming majority (91%) of customers who would pay more for traceable meat. Nearly 67% said they would buy more meat if their traceability was guaranteed (Cunningham, 2008). In line with these results some researches showed that Chinese consumers are very concerned about the quality and safety of agricultural products, and some are even ready to pay for traceability, however, most of them think it is difficult to understand how to receive quality and safety information from the Meat and Vegetable Distribution Traceability System (what was established by the Ministries of Commerce and Finance in China) (Hou, 2011; Bu et al., 2013; Hansstein, 2014). That is why perceived ease of use is an important determinant of technology acceptance within the TAM (Technology Acceptance Model) (Davis, 1989).

A German study which examined the acceptance of blockchain technology revealed the relationship between access to self-led investigation tools and consumers' purchasing decision is quite strong, and the blockchain technology implementation as a traceability and transparency system (TTS) exhibits also high significance for both consumers' quality perceptions and their purchasing decisions (Knauer & Mann, 2019).

Important to keep in mind, that according to Wu et al. (2015), willingness to pay of consumers for traceability information and quality certification were significantly influenced also by gender, age, monthly family income, and education level. More than the half of the Chinese respondents (62%)- according to Wu et al. (2015) especially the male consumers with high education and income levels want to try new things, - in the research of Wu et al. (2012) showed willingness to pay a price premium for traceable food, what is higher than that in Canada (less than 50%), and in Spain (27.5%). Although the average percent of the extra price that consumers were ready to pay was quite low, only 3.15% of the base price (Wu et al., 2012)

According to another study, which examined willingness to pay in the US, Canada, Japan, and UK traceability alone does not encourage the consumer to pay extra, but additional benefits may provide sufficient motivation (Dickinson & Bailey, 2005).

From the side of the interviewed German retail managers this willingness and this interest are not seen. They think the consumers have not articulated a sufficiently strong demand for a complete TTS (Sander et al., 2018). According to the German Government officials' interview (Sander et al., 2018), their main concern about a complete TTS is the financial burden. According to Füzesi et al. (2018)'s survey maximum 10 percent increase in the price could be acceptable for the consumers, but to develop, build and operate an information system requires a significant investment that is not, or difficult to achieve from this rise.

3. Materials and methods

Modeling is a process that allows us to map and solve real-world problems. After all, in some cases, there is no way to experiment with real objects to find a solution. Then we can represent reality by using modeling languages and models. These points which we consider important we include in the model, while the others are omitted. The resulting models are always simpler than the original systems, so finding a solution is also less difficult (Grigoryev, 2014).

In analytical models, as in Excel, the underlying technology is very simple. The data inputs only need to be recorded in a cell and converted to a data output according to the earlier defined context. These pre-written formulas or formulas defined by us can combine and modify the data. However, there are problems where finding an analytical solution is difficult or simply impossible (Borschhev, 2013). In contrast, simulation models, which are best suited to map dynamic systems, create a virtual system that predicts future state changes in the model as it runs. In this case, the rules may take various forms, such as differential equations, state diagrams, or flow process models. In simulation modeling, we distinguish three types of methods. These include discrete event-driven modeling, agent-based modeling, and system dynamics simulation. These systems differ in the level of detail they allow when constructing a model, so they have a different degree of abstraction (Grigoryev, 2014).

Discrete event-driven modeling sometimes called distributed simulation. This only simulates the state changes of discrete points at a time, so the simulation model jumps from one state to another when an event occurs. (Fujimoto, 1990). In this case, it is assumed that nothing (nothing means nothing interesting) occurs between two consecutive events, that is, no state change occurs (as opposed to continuous systems where state changes are continuous).

The agent-based simulation not only serves to reflect interactions between different individuals (and other entities) (Siebers et al., 2010) but also provides a formal framework for the evaluation of hypotheses (Helbing, 2012). In manufacturing and supply chains, this modeling is particularly well-suited, as dynamic process modeling requires real-time, fast adaptation to changing requirements and events (Siebers et al., 2010).

System dynamics simulation allows us to observe the behavior of the modeled system and its reactions to various interventions. These models consist of dynamic change equations, meaning that if the system state is known at a given time, then the system state for the next time can be calculated. By repeating this process, we can move step by step within the desired time interval. However, simulation only helps to predict future states as long as the model describes reality with sufficient accuracy (Winz et al., 2008).

The program we used in the research is AnyLogic, which is a dynamic simulation that allows combining these different systems, which is the most advanced modeling technique. With the help of it, we can model different segments of the commercial because it provides industry-specific libraries, which means we can use the typical tools and processes, among other things, the railway or the material handling branches. Last but not least, it also enables us to convert flowcharts into interactive movies in 2D or 3D.

As there are currently no publications available, which could provide a wide range of different data from consumer surveys in this filed, we had to look for papers mainly from the area of marketing with a connection to food traceability. We defined as it is seen in the table below seven parameters, based on statistics and publications, which affect on the examined population.

Table 2. The parameters of the model (own elaboration)

Name	Meaning	Value	Source
AdEffectiveness	The percentage of internet users, who see an advertisement and open it.	0.1%	https://www.invespcro.com/
InterestRate	The percentage of interest in the ad about the topic of health.	48%	https://www.invespcro.com/
AdInfluence	The percentage which shows after the ad from the interesting topic is seen, how many people will buy the product.	33%	Amandeep et al. 2017
ContactRate	This number shows how many contacts a person has during a day.	13 contacts	Mossong et al., 2008
FriendsInfluence	That shows how many percentages of satisfied users suggest buying the same product.	17.9%	Amandeep et al., 2017
DiscardRate	The percentage of unsatisfied users, who do not want to buy the product again.	38%	Wu et al., 2012
ReconsiderRate	This percentage shows for some reason unsatisfied ex-users decide to use the product again.	0.02%	estimated

The base of our model is a ten thousand population, where everybody -because everybody consumes- is a potential user of the new blockchain-based food tracking system. While in the 21st. century the information consumption patterns have changed we used a statistic, which reflects the internet-based ads. Unfortunately, the framework of the study does not provide an opportunity to present all the variables and properties of the parameters, but the algorithm of the model is described in detail below:

The online advertisements according to invespcro are opened once from a thousand times (AdEffectiveness), and when this act happened, the potential user becomes „OpenAd" user in our model. Nowadays every kind of information can be found on the internet, so the number of potential interests topic is quite high. If the „OpenAd" users interests match with the advertisement's topic -which in our case is 48% (invespcro) because nearly half of the population is interested about health- there is a chance to visit the website of the company and read, watch videos and ask about the offered products, so they become „Orient" users. When they get to know more from the recommended product and they are persuaded they become „Users" if the impact of this information which is provided from the company were effective. According to Amandeep et al. (2017), 33% of new product purchases are attributable to advertising. When a „User" is satisfied with the bought product he can offer, advertise it to his friends and his family. Based on Amandeep et al. (2017) these „Gossips" can make one-third of „PotentialUser" immediately „Users", but if the product not enough good for the consumer he can leave, „Discard„ and become a „Disappointed" customer. According to Wu et al., (2012), the rate of it is 38%. Despite the consumer became „Disappointed" there is a chance to become a „User" again, because either the new advertisements persuade him to try and buy it again, or his situation is simply changed. Based on our estimation the rate of it is 0.02%. The model is based on secondary data from different countries and eras and the construction of it tries to focus on an average user without any specification (gender, age, education level), so the results of it can differ from the country, gender, age-specific ones. Nevertheless, it can be concluded that the model used may be suitable for analyzing the expected fundamental trends. The described model is seen in the figure below.

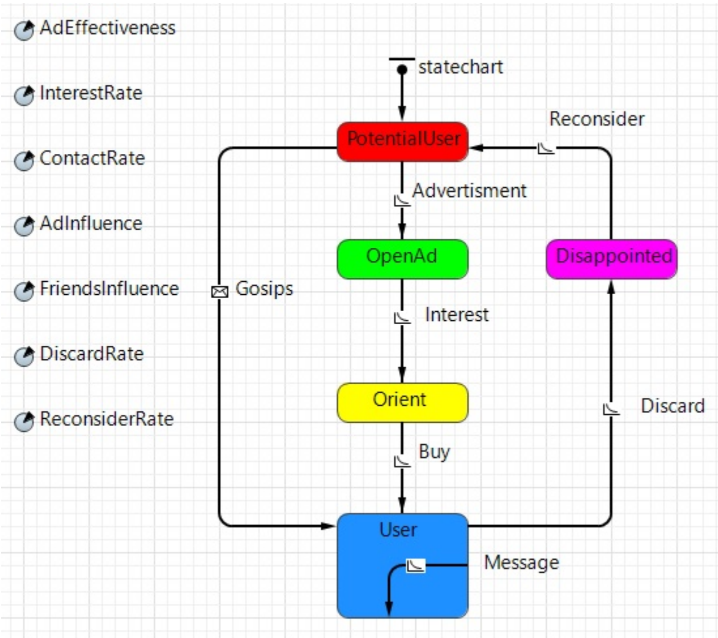

Figure 2. How potential users could become blockchain-based products consumer (own elaboration)

4. Results

Despite the limits, the use of blockchain technology has many useful opportunities in the whole food supply chain (Caro et al., 2018). However, in the business world, companies will only use this technology if it directly benefits them or is enforced by law. Based on these, there are four fundamental reasons for introducing the technology: reducing operating costs through more efficient information management, tightening the regulatory framework (currently, legislation requires only the "one-step-up, one-step-down" traceability), leveraging business partners, and increasing consumer demand for information. The following table summarizes what actors at each level of the food supply chain can use this new technology. Besides, we determined which of the four factors mentioned above may justify the implementation of the solution (Table 3.). (Possible reasons are: CR - cost reductions, R - regulations, P - partners, C – consumers)

Table 3. Reasons for using blockchain technology in the food supply chain (own elaboration)

Material planning	Procurement & integration	Warehouse & Fulfillment	Distribution	Repairs & Returns
The providers store the details of sales and purchases of raw materials, including technical information of products and amounts. ***CR***	The farmers record each stage of the processes (irrigation, fertilizing), including amounts of inputs applied. ***C, R, P***	The producers can store details about the received amount of product from distributors, the packaged amount and the amount of product lost during the processing phase. ***CR, P***	The producers transfer the ownership of the product to distributors, through the blockchain. ***CR, P***	The retailers store details about the sold products, so consumers can transparently verify the whole history of a product before buying it. ***CR, R, P, C***
Producers record information about the planting or breeding process (e.g., the number of seeds used). ***C, R, P***	The farmers record in the blockchain details about the harvesting of slaughtering. ***CR, R***	Stakeholders can store storage conditions, which are essential for traceability. ***R, P, C***	Storage of product-related packaging information, packaging material tracking. ***CR, R***	Dealers can store information about complaints and problematic products. ***CR, P, C***
IOTs and sensors autonomously store the data about the growing plants and environment. ***CR***	The farmers directly can transfer the ownership of the products to distributors. ***CR, P***	Stacked warehouse management and storage of security information to prevent loss. ***CR, P***	Tracking of consignment assembly and its circumstances, measures to prevent tampering. ***CR, R, P***	Store extra tracking data for special products for consumers (e.g., organic foods). ***P, C***

However, it should be noted that the application examples listed in the table, and the reasons for their application were determined from literature sources (not determined by industry experience), because of the novelty of the technology.

Based on the statistics, publications, and our model, we simulated how the population of the different groups will shape, and we estimated how widely blockchain-based tracking systems will be used. This information could be really useful because, according to this, the companies can decide it is worth setting up a new food tracking system or not.

Although the Food Marketing Institute (2018) measured a massive decrease of the public's trust in the food supply chains and parallel an increased demand for food traceability, the number of Blockchain-Based Traceability Systems' users does not show a monotonically increase, even a clear trend is not seen, as represents the table below. The detailed Table 4 shows how the exact numbers of the different groups are shaped after 5 years.

Table 4. The detailed number of the examined groups (own elaboration)

Run(day)	OpenAd	Orient	Users	Disappointed	Potential users
1	7	2	0	0	9991
182	11	24	23	1540	8402
365	16	22	21	2856	7085
547	10	24	16	3948	6002
730	10	16	8	4866	5100
912	8	7	14	5505	4466
1095	6	13	12	6070	3899
1287	7	6	7	6511	3469
1460	7	13	9	6857	3114
1642	8	15	12	7145	2820
1825	7	3	3	7362	2625

According to these data we can say, the number of potential users monotonically decreased, while the number of disappointed people monotonically increased by the years, however, we can not see any kind of regularity in the number of users, even the number of daily users (as it is seen in table 4) is vanishing. We hypothesized that the low number of users was due to a generally low rate of advertising effectiveness, because a huge number of potential users (7000) even did not open any ad, and around 3000 people already tried out the new product but they did not like it and they became „disappointed users" (after 1 year). To test this assumption, the rate of the advertisement's effectiveness was increased with 0.001. The blue line shows in Figure 3. how the new value changed the number of users compared to the original (green) values and the increased interest rate values (orange).

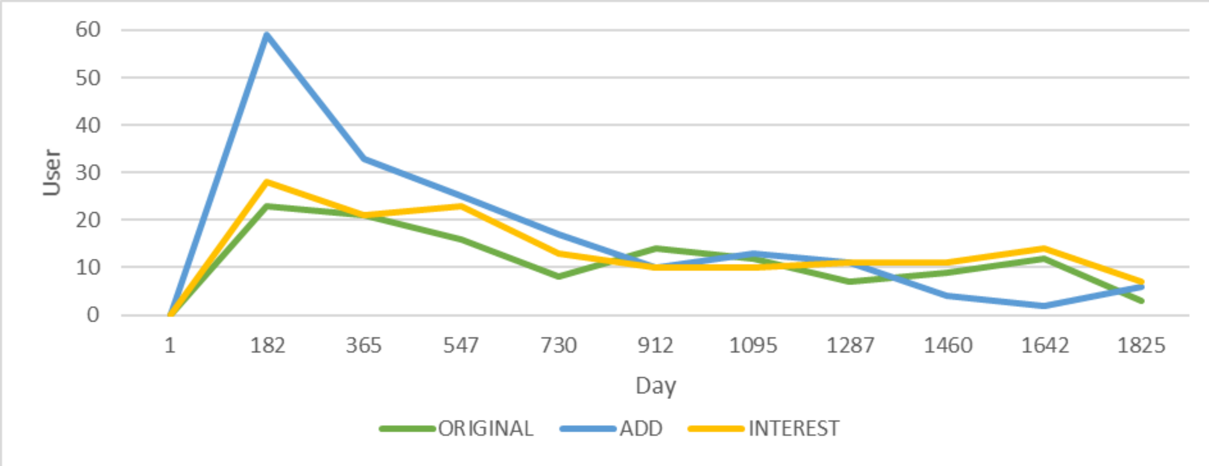

Figure 3. The effect of the changes in the number of users within 5 years (own elaboration)

Even it is seems an increase in the number of users, surprisingly, the change of ad effectiveness did not have any positive effect on the total proportion of it; however, it increased the average proportion of disappointed group with 22%. Based on this outcome, we hypothesized the increase of the interest's rate value – because this variable is the second in state chart, which influences the potential users – could enhance the number of the users. Thus the rate of interest was increased with the same quantity (0.001) and its effects seen with the orange line in Figure 4 above. Even nearly every second person is interested in about health, when we examined the effect of the new value, we measured an 11% higher proportion of total users, while the average number of daily users, in this case, was also only 8. Based on Wu et al., (2012) 62% of consumers are ready to pay a premium for the extra information, so 38% of users will leave because they do not want or not able to pay extra fee for the traceability data even they tried it out, they are not going to be loyal users. While the biggest question of this new blockchain-based traceability systems is, how much extra % (of basic price) have to consumers pay for the information. We hypothesized the companies take a bigger part of expenses (they ask higher prices, but the increase is lower than 10%) or the governments take over some costs of the set up, so a higher proportion of consumers could afford the new traceability system. We analyzed how it would change the size of the groups if our assumption would affect a 0.1% decrease in the value of DiscardRate. In five years caused this lower DiscardRate a 6.46% increase in the proportion of users and a 0.5% decrease in the group of disappointed consumers. Table 5. shows the above-mentioned changes.

Table 5. The affected changes in the examined groups (own elaboration)

	original	increased ad	increased interest	decreased discard
Users (average)	7.2	6.2	8	7.7
Disappointed (average)	7212	8842	7242	7178
Potential (average)	2767	1140	2736	2800

Surprisingly separately, none of the examined parameters had a serious effect on the size of the users' group. Based on our results, the advertisement's effectiveness does not have a positive effect on the users' number, while the decreased discards' rate and the increased interest rate enhanced the size of this group. Whereas the increased interest rate influenced more the number of users than decreased discards' rate, but it is increased more the size of the disappointed group too. According to these results, the companies have to decrease the extra price of the information – or make the governments interested in the set-up of the new system – which could decrease the discards' rate, since the population is already quite healthy-minded. Naturally, the growth of interests towards food traceability would also increase the cluster of users, but as long as the consumers are not involved with this new opportunity and they have no idea what benefits this would bring, the examination of willingness to pay will not provide reliable results.

5. Conclusion

The appearance of blockchain provides so many new features in the food tracking that could satisfy the demand of the consumers. Some researches demonstrated openness from their side to pay more for the traceable food, and the proportion of this group is quite high in many cases, but the idea of the increased price which would provide the set up these new systems is not popular. That is why important to see the proportions of different minded consumers since the companies do not want to invest in a new system which payment is uncertain. According to the available statistics and publications, we measured a lack of interest from the consumers' side, which means in the close future (next five years) this kind of new tracking system is not going to be used by the consumers (if they would be available). The details showed the reasons for it could be the low rate of the advertisements' effectiveness and the high premium price of extra information which could affect a quite huge discard rate. According to the statistics, the population is quite healthy-minded so the advertisers should find better ways to address them and involve them with this new blockchain-based opportunity.

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