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INTERNET OF TOMATOES AS A TOOL FOR ADDED VALUE CREATION. THE MODEL BASED ON THE DISTRIBUTION NETWORK IN NIGERIA

Digital transformation, especially the networking of logistics processes, provides more transparency in the supply and distribution chains which improves supply chain management. The main purpose of the following paper is to present the added value improvement, in the implemented idea according to contemporary solution of Logistics 4.0. Chosen solution is Internet of Tomatoes (IoTo) as a one of the kinds of Internet of Things (IoT) tools. This research paper presents the current state of chosen tomatoes distribution network in Nigeria and tries to precise the added value by using a questionnaire result and proposes the mathematical and BPMN 2.0 model for implementing the mentioned solutions. The article also shows some managerial implication of the considered improvement.

Keywords: logistics, value chain, Internet of Things, distribution network.

1. INTRODUCTION

In today's world, digitization and automation have an impact on the logistics industry. Until recently, the World Wide Web was mainly used as a portal to access information and consumption, but now it is currently undergoing a rapid digital transformation towards the idea of "Internet of Things (IoT) and their Services" (Wortmann and Fletcher, 2015). As this development progresses, platforms for "intelligent" products will emerge that connect people, data, and machines not just agriculture but across every sectors. This has significant consequences for the logistics sector, especially regarding the speed, flexibility, and controllability of processes. Against this backdrop, Logistics 4.0 is becoming increasingly important for companies that want to position themselves successfully on the market and to derive value for the process to achieve best result in the favor of producers and consumers (Amr et al., 2019). The fourth industrial revolution, Industry 4.0, enables companies to proceed in digitalizing their operations, as building a flexible organizational structure is a challenge that needs to be addressed and adopting the digital enterprise model is a crucial step towards implementing the new age technologies, as companies must add the elements of flexibility and adaptability to deal with the challenges at hand. Logistics 4.0, a term derived from the combination of Industry 4.0 technologies and innovations and their

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application on internal and external logistics is a narrower concept than Industry 4.0 (Radivojevic, Milosavljevic, 2019), as it focuses on typical features, such as automation and digitalization. The technologies most utilized are the Internet of Things (IoT), Big Data analytics, Augmented Reality (AR), Unmanned Aerial Vehicles (UAVs) and Advanced Robotics. IoT is the pinnacle of those technologies, as it enables new data streams creation from sources previously being non-exploitable and allows companies to monitor and control mechanizations, fleets etc. by a central system. Big Data analytics provide a powerful tool to companies, as the new data streams generated by IoT produce much greater amounts of data which common software cannot process. Advanced Robotics revolutionize logistics operations due to increasing automation. AR offers numerous advantages for warehouse workers distributors. Lastly, UAVs present a revolutionary technology in many ways as they possess a wide array of applications, such as facility patrolling, warehouse assistance, stock counting and last-mile delivery (Blanco-Novoa et al., 2018).

Digital transformation, especially the networking of logistics processes, provides more transparency in the supply and distribution chains which improves supply chain management. Digitalization particularly improves in the logistics control and implemented on various front of developing logistic value on every item on produced, distributed, and delivered (Seyedghorban et al., 2020). People and machine coherent networking and achieving the great value of digitalization as it associates with the processes. Thus, people control, and nodes coordination will always allow digitalizes logistics to work at a pace where optimum value can be derived, and this will ensure logistics 4.0 works at its best. Some of the main objectives of the fourth industrial revolution can only be achieved if logistics are adapted accordingly. However, companies should consider making fundamental changes to their organizational structures to prioritize the optimization of their logistics operations and add elements such as flexibility and adaptability to insert smoothly into the digital age and implement emerging technologies (Vial, 2019). Logistics 4.0 is not only planned once and then maintained in the same form for all eternity. It is constantly aim at learning new things, constantly adapting to new requirements and is therefore continuously being implemented. Logistics 4.0 focuses on the use of new, innovative technologies, such as forecast-based supply chain management. With this and other new technologies, the following logistical key figures can be optimized (Wang, 2016):

- Delivery reliability: ensuring that delivery is counted upon and can always be trusted to be on time and accuracy as certified.
- Delivery quality: Quality is of integrity and to ensure delivery are always to standardize quality system and standards as agreed.
- Delivery flexibility: Ensure delivery can be change in a process base manner and that it can always meet the trend and new environment or phase changes as situation may be required.
- Ability to deliver: That it can always be counted upon to meet service condition, that to say goods receive will meet customers as schedule.
- Service level: That an agreement which is favorable for the customer and the service team can be drawn up to achieve a permissible relationship

Logistics 4.0 offers a solution, in most cases, as its technologies facilitate greater digitalization and automation in logistics operations, such as the above, thus driving companies towards the digital age with increased capabilities for innovation (Hülsmann, 2015). As a result, Logistics 4.0 can be defined as a data-driven logistics concept in which

individual subsystems intertwine and communicate to create a digital network that enables increased efficiency and productivity (Szymańska, Adamczak, 2017). It operates under the same principles as Industry 4.0, but with different component parts, as it utilizes smart means, such as containers, vehicles, pallets, and transportation systems. By creating the digital network, Logistics 4.0 offers supply chain managers, shippers, drivers, freight forwarders etc. real-time visibility and traceability, thus enabling the optimization of logistics operations, such as warehousing and freight transportation (Hoey, 2018). IoT is the concept widely considered in current literature, but the usage of IoTo is still under the theoretical considerations with few tries of pilot implementation.

Another revolutionary technology which was briefly mentioned above is IoT and its subsidiary technologies, such as sensor technology, with the ability to connect individual components of the supply chain together into a central system to enable digitalization and optimize processes (Macaulay et al., 2015). IoT enables the creation of multiple data streams which results in a more massive amount of data being available, which deems Big Data analytics the most suitable solution, as it enables real-time data processing of datasets much bigger in variety, velocity, volume, and size, thus optimizing decision making and generating greater insights (Zhou, 2013). IoT allows the interconnection, through Internet, of smart devices that share specific information and data with each other and with other remote digital platforms for real-time decision-making by the user or by other smart devices through machine-to-machine (M2M) communication. The global installed base of IoT devices is expected to rise from 27 billion in 2017 to 64 billion in 2025 according to Business Insider report (2019). Internet of Tomatoes (IoTo) is an Internet of Things (IoT) solution for agriculture. This solution consists of three sections; temperature and humidity sensor node, soil moisture sensor node, and PC or mobile app to control system (Shah and Bhatt, 2017) and it allows the farmers to make a smarter decision (Somov et al., 2018). IoTo solutions could be connected in the future with other nowadays technological support like blockchain technologies (Zhang et al., 2019). Main aim of this paper is the identification of a suitable improved value chain process using easy to use basic IoT devices in-cooperated into Internet of Tomatoes (IoTo) methodologies solely for reducing the high wastages in the yield of tomatoes production through distribution channel across the whole chain in Nigeria thereby adding real value into the existing Logistics value chain. The Customers/end user final gets real value in price and true nutrition on tomatoes purchased and while the farmers earn real income on his/her productivity. These make the Nigeria Tomatoes logistics chain competitive and promoting real technological innovation driving it into the new century. To analyzing logistic processes in the chain from harvesting and supply-distribution of choice tomatoes in Nigeria to greatly improve value in the production, and processing of tomatoes/tomatoes products for mass consumption at cheaper rate by mapping an improved logistic process using IoTo devices. These inherently revolve the value chain to meeting key objectives which is real satisfaction for the consumers and economical developed logistics networks of entrepreneurs actively using IoTo to innovate the value chain. The outcome will favorable be low wastages, better pricing, and best earn value on produces push into the chain. Authors will focus on examining the Lakaji corridor in Nigeria and deciphering the logistics network across the corridor with the aid of analyzing the gaps and proffering improves logistics value chain methods. Added value in the following paper is understand as the elements of logistics processes which provides meeting the requirements of final customers.

2. METHODOLOGY

Tomato (*Lycopersicon esculentum*) belongs to the member of the family Solanaceae. The word “tomato” comes from the Nahuatl word tomato, according to Etymology Dictionary, literally known as “the swelling fruit”. Tomato is one of the most important vegetables worldwide. It is an important crop that is grown in the tropics for home gardens, family consumptions and processing purposes. It is a native of south-Central America. It was spread to other countries in the 19th century (Tindall, 1983). Tomatoes can be grown in a wide altitude range from the sub-tropical plains through to the high hills, depending on the variety and sowing dates. Agriculture was the mainstay of Nigeria's economy before the discovery of crude oil. According to PWC report from 1960 to 1969, sector accounted for an average of 57.0% of GDP, and generated 64.5% export earnings. From 1970 to late 2000s, the sector's contribution to GDP export earnings steadily declined, because Nigeria's focus shifted to petroleum exploration. Over the past five years, the sector has contributed an average of 23.5% to GDP and generated 5.1% of export earnings. Due to the recent fall in crude oil prices, to merchants, export earnings from crude oil have reduced significantly. This has triggered conversations around the critical role agriculture has to play in diversifying the economy. Tomato is grown in most parts of Nigeria, however the best area is the Savannah Agro-ecological zone, where diseases and pests affecting tomatoes are less common. Major producing areas lie between latitude 7.5°N and 13°N and within a temperature range of 25°C–34°C. These areas include states in the northern parts namely Bauchi, Benue, Borno, Kano, Kaduna, Plateau, Jigawa and some southern states like Delta, Kwara and Oyo. Tomatoes are warm season crop and are sensitive to high humidity and rainfall. Hence, increases in yield are experienced in well drained, sandy loam, and rich in humus soils. The planting season is between August and September. However, where irrigation farming is practiced, the best time for planting is during the dry season off rainfall months in the year. The combinative ability to collect more data and store it in a trustworthy place allows for restaurants, grocery stores, markets and other food suppliers to better optimize to consumer preferences hence IoT. This has been observed in developing countries with keen interest towards inclusion advancement using IoT. Proposed research model with research steps is showed in Figure 1.

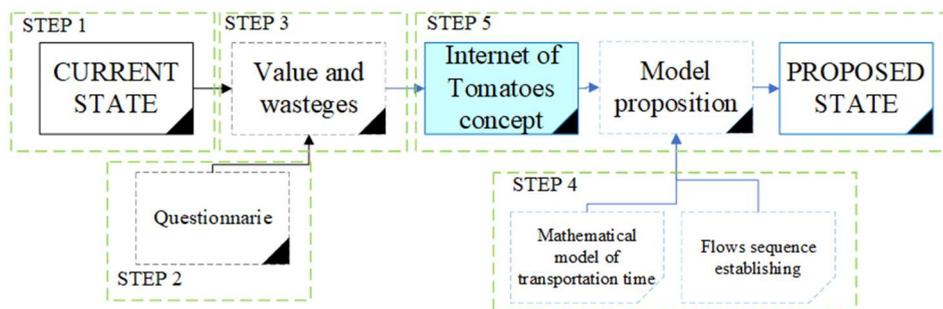


Figure 1. Proposed research model and research steps

Source: own elaboration.

Research starts with precise the current state of tomatoes flows from production yield to customers. This analysis will be focused on value and wastages analysis and will be supported by the results of questionnaire. In the questionnaire, analyzed case of 174 customers from Poland which declare their experience in buying and eating the tomatoes regularly (at least 5 days in week). The research sample of polish customers allows to examine the final customer in the conditions of a long, international supply chains, were the delivery time reduction and providing the best product quality are the biggest issues. Beside this the research sample consist of young customers (up to 30 years old), pointing to the fact of possible beneficiaries of IoT output technology. After that, a mathematical model and main flows sequences to supported new state proposition were established.

3. RESULTS AND DISCUSSION

Reviewing the flow process on the value chain (Figure 2), the supplies input, tomatoes are first raised in farms bare lands or in advance places, nurseries before transplanting to the field. The input supplies required include seeds, fertilizer, pesticides, nursery supplies, greenhouse, ancillary equipment, etc. Most of the inputs are not produced in Nigeria, making procurement more expensive than what the farmers can afford. The difficulty in accessing inputs and technology makes it impossible for farmers to maximize production. Also, most of them have very small land size, making commercial production impossible.

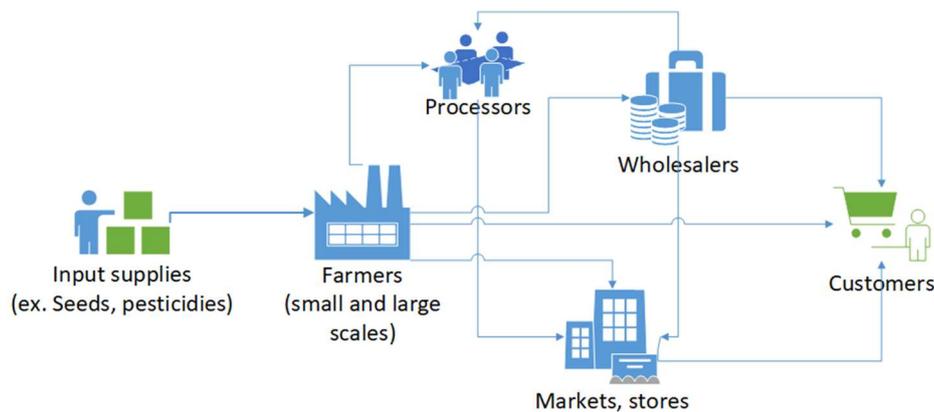


Figure 2. Value chain of tomatoes flow

Source: own elaboration.

The tomatoes logistics chain in Nigeria can be compared with several tomatoes' distribution channel flow across different countries in the global. The Lakaji corridor which is being used as the best model to move tomatoes from Northern-Jibiya to Southern-Lagos in Nigeria is approximately same distance across as; Chicago to Newark in the USA or Burkina Faso-Ouagadougou to Ghana-Tema also in West Africa. Thus, after much of the development, the corridor still lacks many basic infrastructures and rid with under development, these result in years of deterioration of the corridor itself. But in the scope of our research, the corridor has seen the increase of key players toward enhancing tomatoes consumption in Nigeria by increasing the activities and promoting free economics practice

till today. Nigeria is the 14th largest producer of tomato in the world and the 2nd largest Tomato producer in Africa (according to PWC report), with an average of 3.9 million tons per production (FAO, 2014–2018). That is, an average yield of 6.19 ton/ha, compared to the world's average of 38.1 ton/ha and Europe which has an excess of 100 ton/ha.

The questionnaire was aimed at gathering the information about the places where the buyers usually buy tomatoes, the meaning of the delivery time for customer and the meaning of product fully information availability for customers. There were three value questions which define the issues:

- Q1: What place do you prefer to buy tomatoes? (Figure 3),
- Q2: Do you prefer to buy the tomato which delivery time for the market is shorten? (Figure 4),
- Q3: Will you want to have more information about the tomatoes (like for example delivery time, harvest place, supply road) before you buy it? (Figure 5).

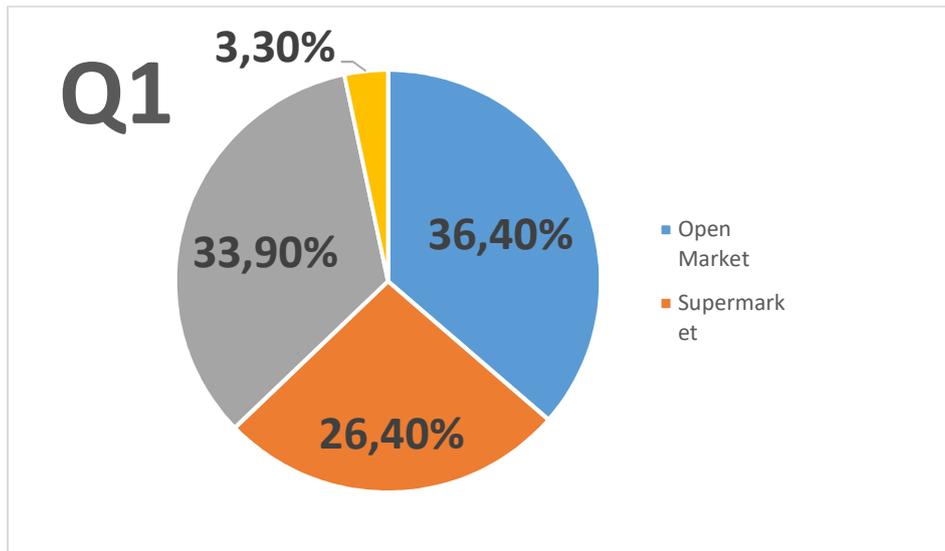


Figure 3 What place do you prefer to buy tomatoes?

Source: own elaboration.

First question is aimed at finding the most favorite location for buying tomatoes. Answers were remarkably similar, so the conclusion is that it is necessary to providing the best solutions and the best deliveries quality in the whole POS (Point of Sales) to ensure the highest level of value in the chain.

Second question was aimed at examining the customers concern about delivery time of the products which there are buying. Majority of responders point towards the delivery time, so it is another step towards focusing the attention in creating the value for customers.

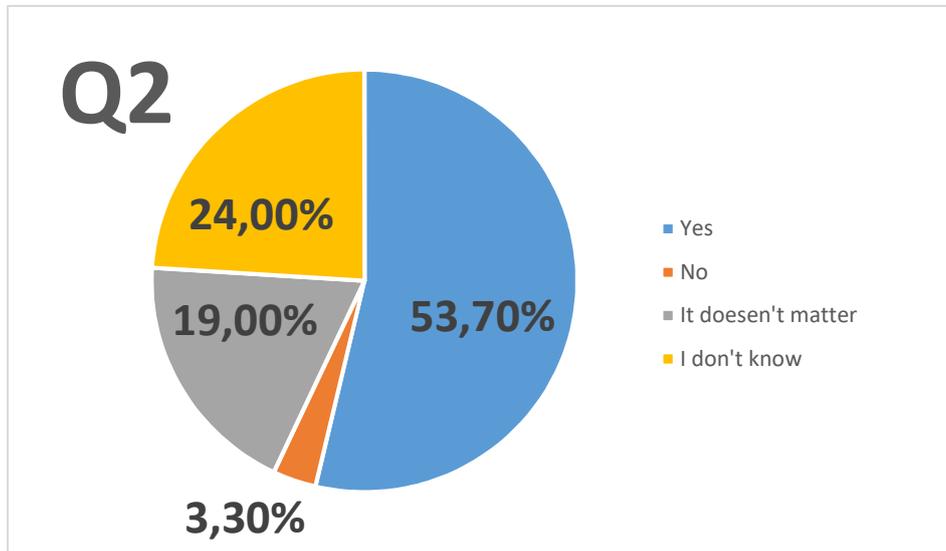


Figure 4. Do you prefer to buy the tomato which delivery time for the market is shorten?
 Source: own elaboration.

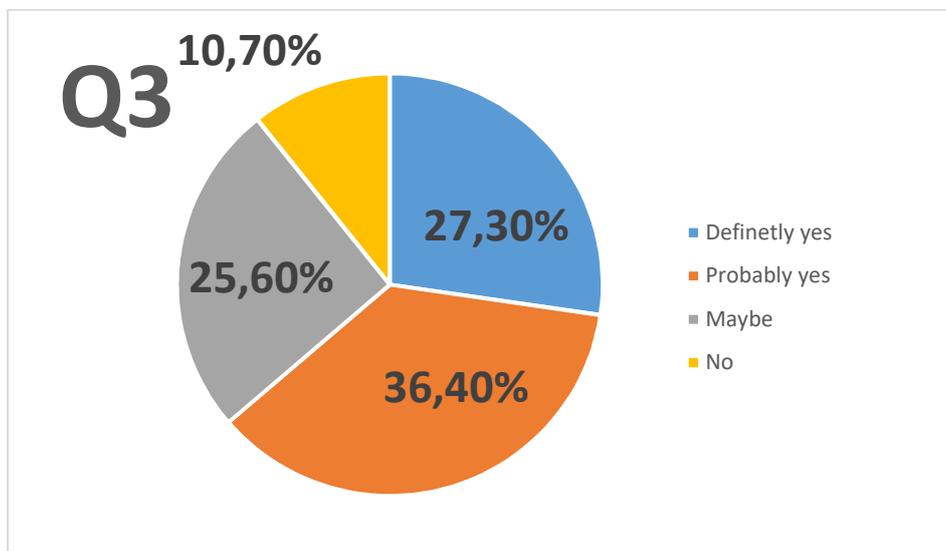


Figure 5. Will you want to have more information about the tomatoes (like for example delivery time, harvest place, supply road) before you buy it?
 Source: own elaboration.

Third question was aimed at finding if the customers wants to know more about the product life cycle. In this case it could be concluded that the customers will be glad to have the possibility of checking the food products history before buying them.

At present, various research done has reveal different amounts for tomato losses in the entire value chain. However, sector experts estimate that the annual losses of tomatoes in Nigeria is between 45% – 60% of the total production depending on certain climatic or economic circumstance which might mitigate the result of the losses. Most of the fresh tomatoes produced in Nigeria are sold in the open market in baskets to the middlemen, while roadside vendors sell those sold to the consumers in small plates and baskets. The tomatoes for processing are supplied to the companies in baskets by the same middlemen. However, currently there are no packaging systems for fresh tomatoes, like other countries except for a few big chain supermarkets, where tomatoes are kept in the refrigerator until sold. These could take weeks and tomatoes become overstayed and priced at high value ruin the value chain system. At end they result in no guaranteed pricing regimes and consumer become the bare of fluctuation and absorbed prices with little or no value added, and chain is again ruin. In a twist of turn, Cold storage facilities are not readily available; as such tomatoes intent to be sold fresh must not be stored for long. Tomatoes that have been processed, for example into tomato juice, or dried or pickled can be stored from several months to a few years where interventions are made for them. Tomatoes often need to be stored at different points while they are in transit to a destination. For example, the tomatoes are picked when ripe and stored for a few days in a cool room or most case outdoor space free from heat, after which they are transported to distant markets some place 700–1500 km, but this component of the value chain needs technology input. The transportation part of the value chains of tomato in Nigeria contributes often significantly to losses. The poor conditions of trucks employed in transport, poor road conditions and insufficient/no cold chain solutions by transporters and middlemen have been raised as the main causes. In addition, it is quite expensive to transport products from the North to South of Nigeria, in fact, sector stakeholders indicate that it costs more to move goods within Nigeria than from overseas. Transporters claim that the high costs are due to unnecessary roadblocks and delays food loss in Nigeria by security personal on highways and the high amounts of multiple taxes they are forced to pay before reaching their destination. To further proceed, analysis start with the questionnaire results, in deducing the preferences which will be applied to creation of the flow map, in achieving the solution intended for improving tomato value chain in scope of processing and distribution drivers ahead towards the consumers satisfaction being achieved. These justify the bases for the research embark on the improvement of the Value Chain in the context of the Nigerian market. An overview of tomato wastages shows over 45% (750,000 metric tons) of tomatoes produced in Nigeria is estimated as annual loss due to poor food supply chain management, price instability resulting from seasonal fluctuation in production and the supply preference of farmers and middlemen to urban market than processors due to low farm gate price (FAOSTAT report 2010). Tomato wastage occurs mainly at the processing, packaging, and distribution stages. This is due to the poor processing technology, lack of good storage system and the transporting system used for the distribution of fresh tomatoes. Basically, the heart of the loss recorded can be corrected by process mapping, hence, to rectify these abnormalities using modeling, a keen sense of identifications of these functional variables is needed. The changes as resulted from core logistics functions will inherently introduces the value being rid-out of the chain in the first place. A careful creation of the processes from harvest to the

market with endpoint being the consumer clearly deterred necessary corrective actions. It is estimated that food loss during production can be as much as 15%, and 30% during harvesting, processing, packaging, transportation, and distribution and a 20% at the markets. Existing map of tomatoes flows as pictured is shown in the Figure 6.

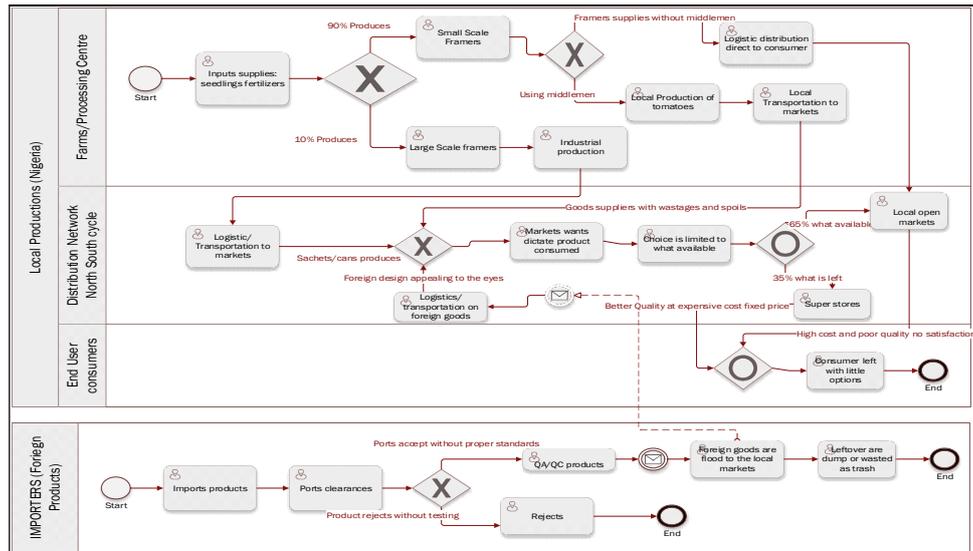


Figure 6. Tomatoes flows chain in BPMN 2.0 – current situation

Source: own elaboration.

Value Chain mapping has always provided the avenue for achieving process improvement on different business cases. These have without doubt being employed across different challenges across the value chain not just Agro-based business in modern societies. As the waste mounts across the chain, it gives a picture of how cost increase rid away all the values to the customer at the end of the chain. Thus, moving forward, to improve this process by adding real value to the customers and minimize the waste as production and distribution is carried out along the chain, creation of a proper map for this improvement will aid in illustrating the process in more clearer terms. The primary areas of wastages in analyzed chain could be divided into two main groups – process and distribution driven losses.

1. The process driven losses were mainly distinguished:
 - a. Spoilage or spillage of tomatoes.
 - b. Poor quality control check of tomatoes.
2. The distribution driven losses where the main wastes are focused around issues like:
 - a. Expiration of tomato products.
 - b. Lack of cold chain infrastructure
 - c. Exposure to unfavorable environmental conditions-heat

Employing basic calculus in deriving the expression on duration across transport network, we can develop the expression base on the theory postulate on the maximum days

predicted to deliver product before it shelves life. Thus, driving the using basic assumption on the transportation duration T_d will be:

$$T_d = \text{Max days } m-t \text{ (Time save)}$$

Assuming that in some case they will be time save on delivery. Thus,

$$T_d = m-t$$

$$\text{So } \sum mmt (m-t)$$

So, carrying out an integral on the summation between upper(mt) time and lower(m) time to arrival at an expression to speak for the delay, we will have:

$$T_d = \int mmt (m-t)$$

Assuming t save only is 1 which is negligible since it could also be 0. Thus 0-1 as forcible limit,

$$T_d = \int mmt (m-t) \approx \int mmt m$$

$$T_d = \int (mt-m)$$

As postulated that it takes average of 15 days to delivery product to end user in case under review, i.e., we shall always be between 0–15 days on duration i.e., ± 15 days totally. But delays are reality, and they occur constantly, so we introduce a $d = \text{delays}$. Our expression becomes:

$$T_d = (m-t) + d$$

But if d is beyond 1 day or unit as case may be, d becomes a multiply of the delays:

$$\sum d = x_n * d$$

Where $x_n = \text{the delays multiply in days or hours}$ & $d = x_n * d$. Thus,

$$T_d = (m-t) + (x_n * d)$$

Where: $d = x_n * d$ as above. Then,

$$\sum mtm ((m-t) + d)$$

$$T_d = \int mtm ((m-t) + d)$$

Thus, if $d = x_n * d$, Assuming the delay multiples by just 1 day

Where $x_n = 1$, $d = 1$, thus no time saved, $t = 0$:

$$T_d = \int mtm ((m-t) + d)$$

$$T_d = \int mtm ((m-0) + 1)$$

$$Td = \int mtm ((m) + 1)$$

$$Td = \int mtm (m + 1)$$

Thus, our delivery will always be scheduled to end a day after plan arrival on normal events.

Carry further on integral between upper and lower limit on plan days max, m:

$$\int Td = \int mtm (m + 1) dm$$

$$\int Td = \int mtm ((mt-m) + 1) dm$$

$$\int Td = \int mtm ((mt-m) + 1)/1) dm$$

$$Td = (mt-m) + 1$$

And if lower limit m is 0 being initial start day, then Td becomes

$$Td = mt + 1$$

Where: Td = is transportation duration & mt = maximum days attained on plan.

Based on report enabling trade forum on formation to value on action-world economic forum (WEF) deduction can be made on the days on vertical plain verse the temperature on horizontal plain on storage of tomatoes across the shelve life. Tomato in their unprocessed state cannot last so long in their temperate state, hence the need to ensure there are distributed as quick as able to the markets place or the customer who are these end users. Nigeria as a climatic region lie between 25°C to 35°C which interpreted from the WEF graph below point to maximum of 7 days on pulled un-ripe tomatoes or 4 days on ripe red tomatoes that can be kept on ground for purchase. Here the essence of tracking shelve life become dined to ensure value is not lost and end users can extract the best benefit from the product on sales. Thus, once distribution and storage/sorting can be close-up in shortness attainable time, i.e., from farm to marketplace/shops, we can expect a sale done under 4 days to close the entire value from Tomatoes supplied. And this will be achieved through use of IoT on first in and first out (FIFO) pricing and value driven process, as products close-in on shelve life it become more cheaper and move more closer to the end-user for consumption. The IoTo system calculate the value on product based of days per shelve life and provide advisory cost with best market to which the products should be sold. It finally anticipates the waste and advise grades and stocks for recycling before products get wasted. Hence, tomatoes are not wasted anymore but sold across IoT channel and as last resort recommend recycling, so the logistic chain is not rid of value flow in and out of the process. A Proposed flows of tomatoes with usage of IoTo conception can be shown in the Figure 7.

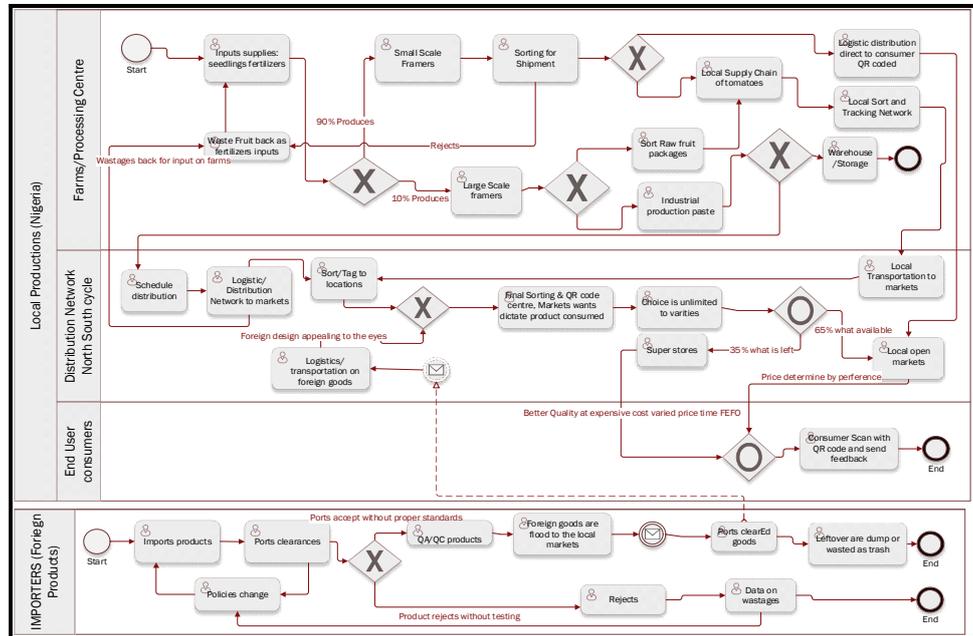


Figure 7. Proposed tomatoes flow with IoTo usage in BPMN 2.0

Source: own elaboration.

4. CONCLUSIONS

The concept of IoTo in logistics value chain can only be first applied when the initial value chain is correctly mapped. With direct focus on Nigeria value chain system and the concept of the Tomato Logistics chain in focus using BPMN reveals how value continues to slip away between the local production and not sparing the imported market in consideration. The entire system is riddled with wastages and losses and the aftermath is inflation of price on product consumers purchase daily. Alternatively, implementation of an IoT model map, it transforms a wastage process by gathering data at bottlenecks and solve scheduling, distribution, and demand criteria all at once. The acceptance of consolidated deliveries and sending smaller loads to the market through distribution network, make the logistics value chain more efficient as the IoTo framework are introduced in analyzing batches, stocks, suppliers, networks capacities and demand needs at various interval. An example of how concept of (Grzybowska, Łupicka, 2017), management principle is applied as the consolidation point is transformed to a Sort, Tagging, and Coding (QR, RFID & Smart code) are introduced to the goods to ensure they reach assigned point. Consolidation and Deconsolidation techniques prove important in resolving distribution. Never forgetting that the premises of the introduction of consolidation point and come with deconsolidation point making the bottleneck fade out and the product cycle becomes easy for the logistics value providers. And at this point, communication across using the IoTo devices, delivers a sufficient data exchange where one can predict and forecast better schedules and distribution across markets and across point of sales in the logistics chain. Main criteria to note, is that the IoTo effectively using existing telecommunication infrastructure and

stakeholder's devices to network and allow logistics value providers to implement flexible approach in price and consumers preferences. In projection, the concept nullified the issues implementing more favorable solution and gathering data need for future policies shaping, price control and above all waste reduction in the Tomatoes Logistics value chain. This concept can be restructure into more other value chains. Traditionally, the most important processing methods of process tomatoes used are concentration (to a paste or purée) and drying either fruit pieces or to a powder finish. Processing allows tomatoes to be kept longer, provides a more varied diet, and means that tomatoes are consumed out of season. For commercial purposes, it is a way of generating extra income and more products are offered to the buyers. Tomato processing has attracted some processing companies to Nigeria. Most of the processing companies are into packaging of concentrates rather than actual processing although a few of them process fresh tomatoes. Above shows that some of the industries are faced with different problems from lack of decent quality fruit for processing to infrastructure problems and lack of processing equipment. Just a few companies such as Dangote Tomato processing factory, Olam Nigeria Ltd., GB foods, Dizengoff have significantly higher revenues and employee size, mostly because they are part of a larger partnering company Group. The bigger companies have competitive advantage given the fact that they can easily raise capital to acquire large farmlands for cultivation, enlarge their processing factory capacity and procure the required equipment and machinery. Thus, most of the tomato products (ketchup, puree, fresh juice, powder, soup) found in the grocery shops are imported. In total, only a few (20%) tomato products are produced in Nigeria, while the majority (80%) are imported (MAN report). Experts maintain that this is due to two reasons, foreign tomato paste is smuggled in from Cameroon and Benin Republic; and tomato supply and processing is still not optimal in Nigeria. But on the other hand, there is an example of India. INI Farms (ag-tech fruit Brand Company) has introduced origin traceability feature for all its fruits in the international and domestic market under the technology program called "FruitRoute". Every fruit under the brand Kimaye, India's leading global fruit brand, can now be traced back to its source by scanning the dynamic QR code on it. So, it could be a reason that the implementation of nowadays solutions based on IoT and IoTo is worthy considerate. IoTo projects where Analog Devices build a complete sensor-to-cloud solution are also using to empowering New England tomato farmers to make smarter decisions during the growing cycle (Somov et al., 2018) and in the future, in the author's opinion, this kind of solution will be used increasingly. However, the productivity and the tasks connected with improvements of operations in production yields and whole supply chains influenced on added value of whole tomatoes distribution processes. The most critical issue is the possibility of time reducing and providing the detailed information about product to customer. Authors are aware of studies limitation. As the most important limitations could be distinguished: small research sample which consists of only one distribution network, the latest trend of reducing the supply chains length (connected with COVID-19 and current geopolitical situation) and simplification of some distribution network parameters which were not considerate in the proposed model (like rapid demand changes and other distribution network disruptions).

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