Novel Model for Quality Control in Agriculture Supply with Intelligent Technologies

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***Abstract*—Supply chain is a fast-developing, consumer-oriented process and converting field. A lot of research is being achieved in the diverse location of the supply chain, and effects are supplied on diverse platforms. Recent investigations carried out all over the world have disclosed that the supply of good quality seeds, fertilizers, and agrochemicals decreases production up to 20%. The loopholes in the current supply chain are to prevent the delivery of original agriculture products to farmers. The automation of the latest AI-based technologies, for example, E-sealed, IoT, and Blockchain in the whole supply chain are underlined. This paper proposed a Smart E-seal-based agriculture supply chain model that accommodates the latest technology issues and business requirements. In this model, tamper-proof, RFID-tagged, and electronically sealed bags are proposed for the delivery of agricultural products to the farmers. For endorsement of this model descriptive survey was conducted to inspect the reliability and internal consistency of farmers' satisfaction and service quality of receiving sealed bags of seeds. The result of the reliability measure was good α=0.807 in this study and it was concluded that all items in the survey were internally consistent and reliable.**

***Keywords*— Supply Chain Management, E-seal based and SCM, E-seal, and Agriculture supply chain**

INTRODUCTION

Agriculture inputs play an important role in getting higher agricultural production. Productivity is dependent on the quality as well the availability of these agricultural inputs. Six important agriculture inputs are seeds, pesticides, credits, fertilizers, and insurance information. The productivity of crops can be affected due to many reasons such as low quality of pesticides available, poor access to the fair market, and unavailability of top-quality seeds at affordable rates of the latest varieties. Farmers are not aware of the concept that using low-quality seeds cannot increase productivity and that hybrid varieties are necessary for replanting crops. Agriculture will be more efficient if developing countries provide greater access to finance, proper arrangements for storage, transport, logistics, and a campaign for educating locals. Due to the use of low-quality seeds of cotton, Pakistan loses approximately nine million bales worth billions of rupees every year [1]. Agri-business continuously lose the market of rice due to miss-handling and unavailability of original quality seeds resulting in affecting the rice exports. The export of rice is the main backbone of the economy for the country while in the last some years business of exportation of rice faced lots of crises and trade has falling downs.

For the growth of crop production, the supply of good quality seeds, fertilizers, and agrochemicals (pesticides, herbicides, and insecticides) is necessary for farmers [2]. In the process of the supply chain, different stages are involved like Store, Transporting, Distributor, and Customer. The networks, whether intranet or extranet which exist within or across firms and as well web technologies in the supply chain result in control costs, trim down paperwork, enhance the satisfaction of the customer, and as well to get a competitive advantage in the market. The use of the internet in the supply chain gives a huge potential to streamline coordination between business holders and customers. By adapting web technologies, different segments of firms have better coordination, which results in a reduction of cost, improvement in services, better customer satisfaction, and ultimately a competitive advantage over rivals [3].

In agriculture, small farmers are using lower quality seeds because High Yielding Variety (HYV) seeds are not available in the market. In some cases, small farmers are not able to buy HYV seeds due to the financial crisis so usage of the low-quality seeds leads to agricultural production financially [4]. Quality agriculture inputs like pesticides, chemical fertilizers, mechanized machinery, etc. are also not available in markets. Due to these reasons, the production decreases up to 20%. For increase in production, there is a demand for higher quality seeds and other inputs to increase production. The government should invest especially in seed supply in rural areas. And another issue is that, in the supply of seeds, more stakeholders are involved which may lead to low-quality seed and agriculture input supply. Lack of quality control, high cost, corruption, lack of education, and the use of imperfect equipment by inexperienced labor are the major constraints responsible for the ineffectiveness of production [5].

Through the introduction of new technologies, farming is modernized but, without the supply of standard and high-quality seeds, the production and quality of crops would be to a great extent decreased [5-6]. The agriculture sector has many issues. One issue is a market distortion which includes

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black marketing and shortage of products. The important issue in supply chain management is the bad logistics infrastructure, comprising the road, railway network, airport, and information system. About 20-25 % of the food materials are wasted due to miss handling, storage, and a lack of transport in most developing countries [7-8]. An electronic seal is used much like a Wax seal for cloth items, classified documents, important deeds and contracts, items for trade, and some other articles. This collectively refers to items that had been stored in a container. The electronic seal may be carried out to cloth items to provide assured safety to items for the cause of integrity and authenticity. This Electronic seal can easily be utilized for the supply of good quality seeds to the farmer. The electronic seal has capabilities similar to a physical seal. The seal at the container prevents every person from unauthorized admission and an unbroken seal suggested that nobody has unauthorized access to the goods. The container may be tracked every time from the starting place to the vacation spot via way of means of the usage of an electronic seal. The electronic seal has an encouraging impact on the performance of the manner which includes reducing logistics costs, reducing stock, growing customer services, and specifically heading off customs inspection which ends up in excessive money-saving according to year.

LITERATURE REVIEW

Several studies have been examined in the literature review, aiming at increasing the efficiency of supply chain and the quality of products, real-time tracking traceability is necessary. The main problem in the agricultural sector these days is the security problem which is deeply affecting agricultural productivity. For decreasing such types of threats and risks, several container-based technologies are utilized for tracking supply chains and monitoring the food. In this context, RFID has a positive impact on the flow of information and security in the supply chain of the agriculture food sector. For this purpose, RFID tags are applied directly on goods, interrogators, or antenna devices are attached which gather stored data from the tag and then send it to a database for sharing in the whole supply chain processes. Products can be monitored to find their status anytime in the supply chain to get real-time accurate information [9-10]. RFID is also involved in the supply chain of medicine in hospitals in terms of ERP systems that control management efficiently. RFID-based ERP systems overcome all the manual operations of dispensing, inventory of medication, identifying critical items to manage supply and demand perfectly, and identifying items that have expired in the hospital will maintain sufficient stock for emergency and non-emergency needs. Blockchain technology is a database that is the decentralized way that can maintain its original condition even if any touched node gets crashed to provide quality and safe foods to the customer. The traceability system can also be used by the government for monitoring food and in an emergency to take some positive steps for protecting it from any danger [11-12].

Agriculture 4.0 is the fourth commercial revolution. This revolution is aiming to digitize the rural food manufacturing method via precision-agriculture in which various technological components are involved such as Internet of Things (IoT), blockchain technology, AI and robotics, big data analysis, cloud computing, cellular communication, and many more. The overall aim of Agriculture is to provide proper guidance and navigation, advance imaging and yield mapping and improve agri-food supply-chain and to analyze the food production life cycle from a project management point of view. It is going to be more effective to offer food protection and financial support at those few locations than meet those needs at tens of millions of geographically dispersed locations [13]. For water conservation on farmland, portable irrigation systems are available which are solar power and sensor-based. This system consists of wireless communication. For smooth operations, the system may be controlled through an android app enabled with a Bluetooth network. The consumer experience lets in choice of both manuals manage for scheduled irrigation or computerized-manage using wireless sensors. [14]

In global trading, 90% is done through cargo containers and it is serious for the whole world to protect it from the threats of theft, terrorism, or damage. The traditional containers have been replaced by Smart containers, by using different technologies like WSN, Radio Frequency Identification Tags, and Electronic Seal. The smart container has a modular design that uses some other sensors as well to detect other substantial parameters like atmospheric temperature, shock, vibration, light, temperature, and pressure. The Electronic seal transmits the necessary information about the container through the use of a Radio Frequency device bypassing the reader device and providing an alert if the container is facing unwanted situations [14]. For the recovery of the recurring manner of data entries by the user, an “Automated Application System” has been developed which provides all the necessary information to connected organizations automatically. This system is implemented through satellite communication and the Global Positioning System (GPS) which automatically provides necessary information as well as different operating conditions of the truck to the main headquarters. For tracking, tracing, and global visibility of shipment on a supply chain, a system has been introduced which contains a container tracking service (CTS) system, Global Positioning System (GPS), and Low Earth Orbital (LEO) satellite. By introducing the mentioned systems in the supply chain, the advantages are to track the correct position, and the situation of goods, save the expenses of damage and loss, and give competent and effective information because the internet is low priced and friendly to the user [15].

Wireless Sensor Networks (WSN) in a supply chain can grant a huge range of functionalities to provide results with high speed of operation and efficient energy. By using such a

system, the whole transportation process can be observed, in the technology of wireless sensor network (WSN), the active transport tracking devices (ATTDs) have been attached to items in trucks or containers in the supply chain. The temperature sensor on the ATTDs observing the temperature of goods and in any dangerous condition will inform through an alarm. the pallet's tracking device is detecting the surrounding of goods for harmful products, in the same way, inform the responsible user at that time and also inform the company whether right the truck has been loaded or not and unloaded in the correct warehouse [16].

Previous to the 21st century, while shipping goods to the wholesalers, there were chances of interference or black marketing on the way but with the introduction of electronic seals this problem has been recovered. The electronic seal is performing functions just like a physical seal. The seal on the container prevents anyone from unauthorized access and the seal unbroken indicates that no one unauthorized person has accessed the goods. The container can be tracked anytime from the point of origin to the destination by using an electronic seal [17]. For integrity and authenticity, an electronic seal is used just like a Wax seal for material goods, documents, deeds, contracts, goods for trade, and any other article. The electronic seal can be applied to material goods to give guaranteed protection to goods for integrity and authenticity. For example, the transfer of milk is temperature sensitive so if the temperature is within the range then the seal is valid otherwise it will be broken which will never be recovered and through checking the seal at the destination point can understand the temperature level on the way [18]. Due to the increased requirement of security in the international supply chain, the Electronic seal has an encouraging effect on the efficiency of the process including decreasing logistics costs, decreasing inventory stock, increasing customer services, and especially avoiding customs inspection which leads to high money-saving per year. Electronic seals are not only used for physical security but also can contain some important information such as container number, seal number, user data, security, battery, and environmental information for those who want to track it from a centralized system through the wireless network. Different types of electronic seals have been used which are Container Security Device, Reusable or permanent active RFID electronic Seals, and non-reusable electronic seals [19]. This paper deals with several technologies and their impact on supply chain management through an extensive literature review as shown in Table 1. It has been utilized in the supply chain to track information about different processes in the supply chain and stay connected to the shippers, receivers, and service providers.

The literature concludes several existing technologies which were embedded with the different supply chain in order to reduce shippers, receivers, and service providers' problems and track information about different processes in the supply chain. Farming is the natural strength of the land for the economic purpose and to create a lot of food items. Different agribusiness items like seeds, manures, and pesticides assume a significant job in getting higher agricultural generation. This efficiency is subject to the quality of the accessibility of these agribusiness inputs. Agriculture supply chains are used to supply agricultural products to farmers but still, there are chances of adulteration from both inside and outside of the supply chain.

Table I. Supply Chain Technologies

S. No.	Sensors	Communicating Channel	Tracking System
1	RFID Tags	WSN	GPS (Global Positioning System)
2	Barcodes	Cloud Computing	CTS (Container Tracking Service)
3	Electronic Seals	Block Chain	LEO (Low Earth Orbital)
4	Temperature Sensor	Big Data	ATTDs (Active Transport Tracking Devices)
5	Light Sensor	-	-
6	Pressure Sensor	-	-

To minimize the loss of products and maximize the profits of agriculture an E-sealed-based agriculture product, a supply chain model has been proposed which will enhance the chances of supply of the original company's agriculture products to farmers to use standard quality agriculture inputs to increase the productivity of agriculture.

PROPOSED SMART E-SEAL BASED AGRICULTURE SUPPLY CHAIN MODEL

The proposed E-Seal based Agriculture Supply Chain Model is consisting of four modules. The architectural view of the proposed Smart E-seal based agriculture supply chain model is shown in Figure 1 and the role of each module is described below

Company Module

In order to mitigate the effect of forgery during the supply of the company's product to end-user i.e. Farmer, it is necessary that the bag should be made of tempered proof material. The proposed model states that the bag should have only one open side, which will be sealed electronically. The purpose of such a bag is to minimize the possibility of the supply of damaged bags in the supply chain.

The used RFID is active RFID and fixed on the inner side of bag in such a way that it will not be damaged or disturbed while shifting in the supply chain.

The bag has a one-sided opening, and that opening is sealed using the electronic seal. The electronic seal has the capability of saving and recording its tampering which can keep the company updated via the internet at any time.

The code is stored in an RFID tag which is fixed in each bag and another e-seal opening code is stored against it in the company's database server. This e-seal code is sent to the farmer's application based on specific user ID and then to e-seal of the bag via Bluetooth, finally unlocking e-seal of the required bag.

During loading the container, the scanner of the company will scan the bags equipped with agricultural products automatically and if a bag is found tempered or damaged will be disposed of.

Agriculture product department, which is a source of standard agriculture products sealed and then delivered those products to farmers via all involved stakeholders. The agriculture products company's e-sealed bags of products are transferred and stored here. Another responsibility of the department is to maintain inventory and deliver products to dealers. The technical department is responsible for tagging or storing a specific code on each bag against the stored code in RFID Tag. The tagged code can be read by anyone through a reader, so for the sake of security, the database will store code in reference of user name. Other Applicants who have an RFID scanner will not be able to get the code from a database without permission. The placement of online orders by different stakeholders in the supply chain is in control of the technical department. Agriculture Products Company has a database server for the verification of products and gathering real information of products. Code is stored in an RFID tag which is fixed in each bag and another e-seal opening code is stored against it in the company's database server.

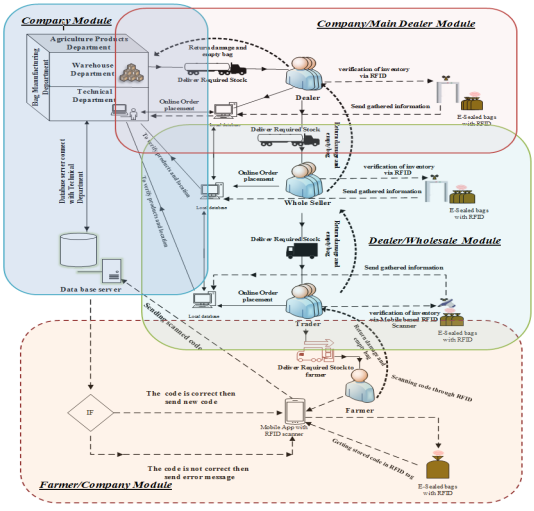

Fig 1 .Smart E-seal based Agriculture Supply Chain Model

This e-seal code is sent to the farmer's application on the basis of specific user-ID and then to e-seal of the bag via Bluetooth, finally unlocks the e-seal of the required bag.

Company/Main Dealer Module

Generally, a company has several dealers, each of which covers a specific region of the country and responsible for the provisioning of the company's products to sub-dealer/ wholesaler in that region. All dealers have registered with the company, with their unique ID, and the company allocates a block of RFID and E-Seal ID for each dealer. Upon delivery of products, this will make sure that the supply of the product is secure and to avoid adulteration.

When a company receives an order, the company will check stored ready-packed bags in the warehouse department that whether they can deliver from stock or not. In the above verification, the stage company verifies the inventory of the warehouse Then, if the required stock is ready for delivery, the company confirms the order otherwise it delays the order. When an order is confirmed, then the company delivers the required stock to the dealer. Once the agriculture products bags are received by dealers, they can scan the whole inventory automatically via RFID scanner gate. All stakeholders in the supply chain have RFID scanners by which bags are scanned. The system is connected with company so, do verification of damaged bags for company that how many bags are damaged when they are delivered. In the whole supply chain, stakeholders have RFID readers and they can scan automatically the whole products at the same time. The damaged and empty bags verification goes to the company online. After scanning and verification, the damaged and empty bags at that time are returned in the same container by which company has delivered.

Dealer/Wholesale Module Module:

When an order is confirmed by Dealers, then they deliver the required stock to Wholesalers and Traders. Once agriculture products bags are received by Wholesalers and Traders, they scan the whole inventory automatically via RFID scanner gate. By scanning bags, the system is connected with company, do verification of damaged bags for company that how many bags were damaged when it is delivered. The scanners of each stakeholder involved in the supply chain will be connected via GPS with the company, whenever the bags will be scanned then the company is informed that in this location the company's bags have been scanned.

Farmer/Company Module:

The Farmer has a mobile application having an RFID scanner. Mostly the farmers are illiterate, and they cannot use ordinary mobile applications so, the used mobile application is considerably easy in use especially for farmers. Having Bluetooth for pairing with the Bluetooth device installed in e-sealed bags so as to open e-seal of agriculture products

automatically.

Farmers or end-users receive agriculture products bags from the local traders on the basis of specific used-ID. Local traders have access to the agriculture product Company's server to update it according to the user-ID of farmers to which the bags have been given.

RESEARCH DESIGN

The methodology approach of research shows substantial and dependable information for the problem under scrutiny. A descriptive survey approach embraced for the exploration is to gather unique information for depicting a populace too enormous to even consider observing legitimately. For endorsing and verifying the model proposed, a descriptive survey was conducted. Analyzation of the survey results was performed by applying Cronbach's alpha [20]. This investigation questionnaire comprises 5 Likert-type scales. This is survey research that investigate primary data only for measuring the reliability and internal consistency of farmer satisfaction and service quality of receiving sealed bags of seeds. The target populations of this research study were domestic farmers and distributors. For reliability and internal consistency, the reliability analysis of fifteen questions for farmers' satisfaction and service quality was carried out.

Data collection procedure

To gather the views of experts, design a collection of questionnaires to gain knowledge from the observations gathered on each aspect of the proposed framework. To design a set of questions, get help from Survey Monkey (System Application), System Usability Scale [21], and User Interface Satisfaction Questionnaire [22] that refers to the analysis of usability and system capabilities. Data were collected through unstructured interviews with domestic farmers. The purpose of using unstructured interviews is to guide participants towards research through pre-formulated questions that guide the research process.

Reliability Analysis

After gathering responses from the two categories, we accurately analyzed those using statistical tools. This study included quantitative research using the Statistical Package for Social Sciences (SPSS version 20) for data analysis. The data were analyzed using descriptive statistics using Cronbach's alpha to assess the reliability and internal consistency of farmers' satisfaction and quality of service in accepting sealed seed bags.

All research questions (RQ) were answered on a Likert scale of 1-5 from strong agreement to disagreement. In this phase, this study gathered 350 domestic farmers and distributors as participants to respond.

Results and Discussion

Table 2 shows the Reliability Statistics table that gives Cronbach's alpha coefficient. For reporting the final Cronbach's alpha, reliability is a number that ranges from 0 to 1, with values closer to 1 indicating higher reliability. Generally, Cronbach's alpha measure to have reliability above 0.7. In this study, $\alpha = .81$, which shows the questionnaire is reliable. Scale Statistics shows descriptive statistics for the questionnaire as a whole. The Item Statistics Table 3 provides means and standard deviations for each of the question items. Table 4 highlights the item-analysis column entitled "Item-total Statistics". It gives productive outcomes as one can choose item(s) to erase and therefore the estimation of the coefficient of alpha may increase. The mean and variance of the accumulated scores without item 1 is 41.00 and 140.828 respectively. According to the rule-of-thumb coefficients of correlation should be at least 0.40 that indicating the correlation is fair. The attribute caption "Corrected item-total Correlation" were designed to identify the correlation of the item designated with the accumulated score for all other items. Cronbach's Alpha if Item Deleted is the most important attribute that shows the reliability coefficient (Cronbach's alpha) for the measurement of the internal consistency of a scale if a single item is deleted from the scale. If a single item is deleted from the scale here, 0.270 compared to the value of alpha 0.807.

TABLE 2 Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0.807	0.807	15
Scale Statistics		
Mean	**Variance**	**Std. Deviation**	**No. of Items**
44.23	160.929	12.686	15

TABLE 3 Item Statistics

RQs	Mean	Std. Deviation	N
RQ-1	2.94	1.526	350
RQ-2	2.94	1.709	350
RQ-3	3.23	1.628	350
RQ-4	3.04	1.639	350
RQ-5	2.91	1.672	350
RQ-6	2.96	1.662	350
RQ-7	3.03	1.610	350
RQ-8	3.18	1.582	350
RQ-9	2.96	1.583	350
RQ-10	2.92	1.623	350
RQ-11	3.07	1.563	350
RQ-12	2.90	1.622	350
RQ-13	2.69	1.640	350
RQ-14	2.88	1.700	350
RQ-15	2.57	1.618	350

Table 4. Item-Total Statistics

RQs	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
RQ-1	41.29	149.449	.245	.100	.808
RQ-2	41.29	139.959	.446	.255	.794
RQ-3	41.00	140.828	.452	.270	.794
RQ-4	41.19	137.175	.549	.385	.787
RQ-5	41.32	136.229	.561	.387	.786
RQ-6	41.27	138.300	.508	.311	.790
RQ-7	41.21	140.055	.480	.311	.792
RQ-8	41.05	141.759	.443	.266	.795
RQ-9	41.27	141.257	.456	.265	.794
RQ-10	41.31	143.893	.370	.178	.800
RQ-11	41.16	145.581	.342	.170	.802
RQ-12	41.33	147.759	.267	.138	.807
RQ-13	41.54	144.478	.349	.167	.801
RQ-14	41.35	143.918	.346	.195	.802
RQ-15	41.67	141.083	.448	.228	.794

Reliability analysis was carried out on the perceived task values scale comprising 15 items. In this study Cronbach's alpha showed that the questionnaire reaches acceptable reliability, $\alpha = 0.807$. Most items appeared to be worthy of retention, resulting in a decrease in the alpha if deleted. On the basis of reliability analysis, this study endorsement the reliability of the proposed model and its prototyping

CONCLUSION

Supply chain management is an essential element of change management. This calls for a non-stop version of community enterprise mindsets. This is an extra essential fulfillment component than another kind of fee chain practice. In this paper, a smart E-seal primarily based on the totally Agriculture Supply Chain Model is offered to maximize company earnings through the supply of the best product (seeds), and solve the complex management issues resulting from a huge variety of markets. The company could be capable of offering original, true and great agriculture products to farmers or users. The agriculture products bags cannot be opened without the permission of the specific user on the basis of confirming his/her particular ID or user name and at the end result enhance country's Gross Domestic Product (GDP). For the verification of the proposed model, a descriptive survey was conducted and the survey result was analyzed by applying Cronbach's alpha to inspect the reliability and internal consistency of farmers' satisfaction and service quality of receiving sealed bags of seeds. The questionnaire is accepted as reliable by obtaining a good level of Cronbach's alpha. The result of the reliability measure was good $\alpha=0.807$ that was concluded all items in the survey were internally consistent and reliable to assess the attitude and perception of farmers' satisfaction and service quality of receiving sealed bags of seeds.

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