Situational Analysis of Shallot Supply Chain Innovation System: A Case Study of Majalengka, West Java, Indonesia

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***Abstract*— Situational analysis is an important study to understand the root causes and solutions that are relevant to a phenomenon. The study aimed to conduct a situational analysis of the shallot supply chain in Majalengka Regency, which experienced problems with production and price instability. Without a clear situational analysis, intervention becomes more difficult. Situational analysis is carried out using a soft system dynamics methodology (SSDM) approach. The real-world phenomenon is depicted in a rich picture chart. Relevant systems are obtained through CATWOE analysis including; Systems production infrastructure, especially irrigation networks; System of training for breeding bulb seeds; System for specialized institutions as a product absorber, guarantor of product quality, and regulator of price stability; System of processed product development; and system that provides GAP training of shallot production. The relationship in the system is illustrated through a causal loop diagram (CLD) chart. This paper has a novelty in terms of content and methodology by conducting a comprehensive situational analysis on the agrifood sector from upstream to downstream in the framework of the innovation system using the soft system dynamics methodology (SSDM) methodology. This paper contributes in the form of a detailed and holistic situational picture and feedback mechanism that emerges from a CLD. The next step of research is analyzing the behavior of the model and developing a scenario of policy interventions that can support the development of innovation systems in the shallot supply chain.**

***Keywords*—** *Innovation system, Production and downstream, Supply chain, Soft system dynamics methodology*

1. Introduction

Shallot is a horticultural commodity that can play a role in causing inflation and deflation, hence the balance of supply is important. Even though the production is always surplus, the condition is not a monthly surplus. Supply scarcity always occurs in certain months, especially during off-season [1]. This creates a classic problem for farmers, namely price fluctuations. When production is abundant, it drives the price of shallots down so that it harms farmers, whereas when production is low in the rainy season, the price jumps so high that it is beyond the purchasing power of some consumers [2]. This phenomenon reflects the existence of market symptoms that are less consistent with the influence of supply-demand, so the balance of supply-demand becomes very important.

This phenomenon occurs in almost entire shallot centers including Majalengka Regency. Majalengka Regency is chosen as a research site on the consideration that the region is one of the potential areas for the development of shallot production in Indonesia. Majalengka has the characteristics of a region ranging from lowland, medium land to highland, thus it has different characteristics of farming. Every year the shallot production in Majalengka Regency shows an increasing trend but still shows production fluctuations which lead to price fluctuations. The increase in the average land area of 204,4 ha/year with an increase in average production of 2.804,4 tons/year [3]. Indeed the trend of increasing production can increase farmer income, but the reality is not the case. Increasing production does not have a significant impact on farmer income. The abundance of production decreases prices, resulting in losses for farmers. This illustrates the existence of fundamental problems regarding the

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pattern of supply chains related to production and downstream on shallot farming.

A supply chain is defined as a strategic framework based on network structure, business process and management components [4]. Another definition states that a supply chain is a number of physical activity and decision making related to the flow of product and information as well as the flow of money [5], [6]. Meanwhile, supply chain management aims to coordinate stakeholders, develop customer value-adding, maximize profit and maintain competitive advantage and service level [7]. The traditional supply chain vulnerable to various types of disruptions caused by uncertain economic cycles, consumer demands, natural disasters, and a large number of actors involved [6]. In the end, this becomes a significant obstacle that is the difficulty of meeting the quality standards of agricultural products [8].

Unstructured multi-dimensional and complexity requires a system thinking to ensure a sustainable and inclusive supply chain through the innovation system framework. Innovation is defined as a new product (goods or services) applied that is increased significantly, process, new marketing method, or new organizing method in business practices (including agriculture) [9]. In carrying out its functions, each supply chain's main institution does not stand alone but there are supporting institutions and influencing institutions forming a system. Agricultural Innovation Systems includes the main actors (agricultural technology knowledge and providers, users, and intermediaries institutions who facilitate their interactions); potential for interaction between actors; agricultural policies and informal institutions, and practices that support or hinder the process of innovation [10].

To examine further the root of the problem of supply chain innovation systems that lead to the synchronization of production and downstream, a preliminary study is needed in the form of situational analysis that can describe the conditions of the innovation system holistically in the shallot supply chain. Situational analysis is a study to determine the current condition of the object under study, to provide knowledge about the actual conditions at that time [11]. This is supported by research Int. [12] indicating the absence of a systematic and holistic approach for Supply Chain Risk Management (SCRM) in identifying the spread of risk in complex supply chain networks.

The distinctive feature of this research is to use the soft system dynamics methodology (SSDM) which combines the concepts of Soft System Methodology (SSM) and System Dynamics (SD). SSM is an organized way to handle complex social problem situations so it is possible to identify systemic changes as expected. However SSM does not have strong technical capabilities, so it cannot realize the real impact of proposed changes [13]. While SD can predict the dynamic behavior of a system from various sources of information. But SD cannot clearly distinguish between Problem Solving System and Problem Content System [14], [15], two basic aspects that must be considered in systemic interventions. SSDM assimilates it in terms of its methodology. SSDM method can present the interrelationships between variables studied systemically in complex social situations and describe the interactions of each system [13].

The purpose of this study was to conduct a situational analysis of the shallot supply chain in Majalengka Regency. This research has a novelty in terms of content and methodology by conducting a comprehensive situational analysis on the agrifood sector from upstream to downstream in the framework of the innovation system using the soft system dynamics methodology (SSDM) methodology. The contribution of this research is expected to produce a detailed and holistic situational picture and feedback mechanism that appears from causal loop diagrams.

2. Method

The situational analysis of the shallot supply chain innovation system is carried out using a soft system dynamics methodology (SSDM) approach, namely the synthesis methodology and dialectics which emerged from a combination of two system-based methodologies [13]. In total, SSDM includes 10 stages across three things: (1) The real-world; (2) The problem situation (system thinking world); and (3) The solving situation (system thinking world), which in turn will produce the desired solution [13]. However, not all stages must be carried out, it depends on the problem to be solved and the commitment and readiness of the organization concerned to implement the intervention in a way implementing selected options [16]. This preliminary research carried out until the 4th stage by crossing two things, namely: (1) The real world; and (2) The problem situation which produces output in the form of a causal loop diagram (CLD). A framework of thinking is explained in the following figure 1:

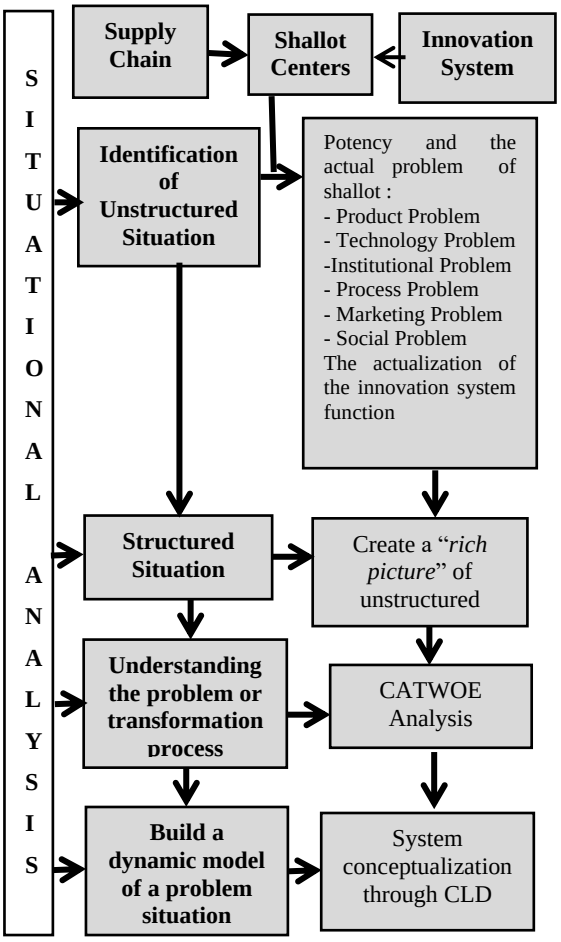

Figure 1. Thinking Framework of Shallot Supply Chain Situational Analysis

The stages are explained as follows:

a. Stage (1) and (2) understand the problem of whether there are structured or unstructured parts, the unstructured part is made into a structured part through the rich picture (part of the SSM process) to help understand the phenomenon.

b. Stage (3) understanding the problem or the process of transformation of the problem which means why the phenomenon can occur and try to express the problem through CATWOE analysis. Based on the root problems in shallots agribusiness, CATWOE analysis is explained as follows:
   - Customer: C (beneficiaries): shallot farmers, intermediary traders, and consumers
   - Actors: A (actors who carry out the transformation): Farmers groups, intermediary traders, cooperatives, central and regional governments, Universities, Research and Development Agencies, professional associations.
   - Transformation: T (change): Establish an innovation system model that can stabilize supply and prices at the producer and consumer level by involving the three agents (production, supporters, influencers)
   - Weltanschauung: W (meaningful perspective): multistakeholder collaboration to support supply and price stability in shallot agribusiness, thus an effective, efficient and mutually beneficial distribution is expected to be achieved.
   - Owners: O (the party that might stop the transformation process/user): Farmers groups, cooperatives, intermediary traders.
   - Environmental: E (environmental constraints): shallot farmers' skills, culture, climate anomalies, access to information and technology.

   By looking at the results of the CATWOE analysis, then examine the formulation of changes due to the comparison of models and the real world.

c. Stage (4) builds the system dynamics model phase 1 (System Thinking) of existing situations and phenomena by creating a Causal Loop Diagram (CLD).

   A supply chain is a system. While the model is a logical presentation of systems, entities, phenomena or processes [17]. The system is a real environment in modeling. The shallot distribution system involves many groups, ranging from farmers, farmer groups, warehouse management, collecting traders, wholesalers, retailers, and finally to consumers. The system can be simplified with a model. Specific behavior patterns and system structures can be described with CLD. Positive cause-effect circles produce "growth" behavior, known as the "R" type Reinforcing loop. Whereas the negative cause-effect circumference results in the attainment of "goal-seeking" behavior. The negative causal circle is also a balancing process with the notation "B" [18]. CLD makes it easy to conceptually build how the system works.

3. Result and Discussion

3.1 Unstructured Problems

One of the 2015-2019 National Medium-Term Development Plans in the field of horticulture contains a direction for developing strategic commodities including shallots [19]. Shallots are designated as strategic commodities because they are included in 14 basic needs based on Presidential Regulation No. 71 of 2015 concerning Stipulation and Storage of Prices of Basic Needs and Important Goods on June 15, 2015. The underlying factors of commodities are classified as staple goods, including the amount of the allocation of high

household expenditure, the effect on inflation, and the amount of nutrient content for human needs [20].

Disclosure of unstructured problems in the shallot supply chain innovation system is carried out using descriptive analytical methods, namely explaining the problem descriptively based on actual conditions [21]. Condition of the problem of the shallot supply chain innovation system includes:

3.1.1 Production Problem

One of the causes of high production costs is the need for seeds. Components of seedling costs reach 30-40% of total production costs. Farmers work the lowland and medium land get 90% of the seeds from outside the area obtained by buying, hence the production costs become high. The reason farmers don't want to breed their seeds that is impractical, the risk of high failure, and the psychological suggestion that imported seeds are far more qualified and have high growth performance. In highland farmers, the opposite occurs. Most farmers also act as seed breeders. Breeder farmers are fostered and supervised by seed certification agencies in the supply of certified seeds. Seed self-sufficiency can save production costs with an efficiency level of around 30-40%.

In the lowland and medium land, shallots are only planted once a year, namely the Dry Season 2 (July - August) and harvest (October - November) provided the irrigation water is available properly. During the rainy season, farmers are concerned about rice cultivation and wet vegetables. In the highlands, farmers grow shallot throughout the year because they are the main source of income and already have seeds ready for planting. Shallot farming in the highlands is an ongoing activity continuously.

3.1.2 Price Problem

Lately, shallot farmers in Indonesia are facing a difficult situation. Yields are often priced cheaply even below the cost of production. The drop in prices in the market was inseparable from the impact of the agricultural area development program for shallots without adequate market access which made abundant supply [22]. The development of shallot prices at the consumer and producer level for 20 months showed a significant difference. The data obtained are presented in Figure 2.

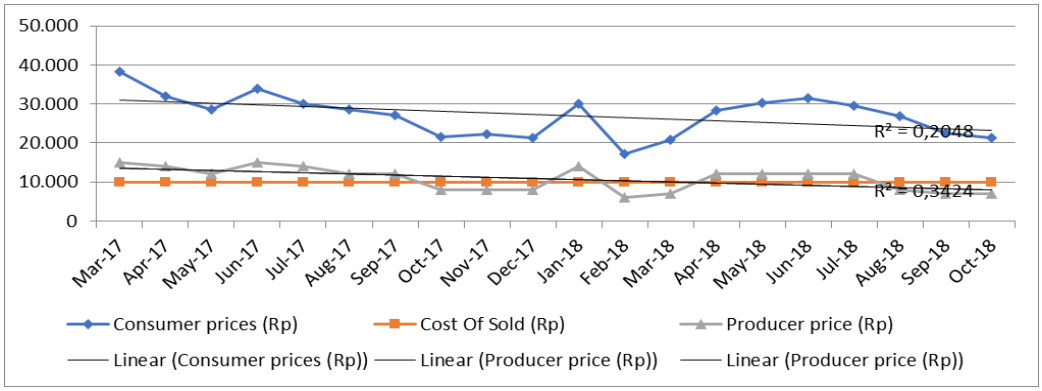

Figure 2. Development of Shallot Price in the level of Consumer and Producers in 2017-2018 (Report of Food Price per Month in Majalengka Regency, 2018)

As seen in Figure 2, the development of shallot prices at the producer and consumer level for 20 months tended to decline with an average decline at the producer level of 34,2% and the consumer level of 20,5%. The trend of falling prices at the producer level is higher than the consumer level in the same period. This indicates that prices at the consumer level and producer level are not vertically integrated. The average price received by producers is not much different from the cost of production. The average cost of production is IDR 10.000, while the average price received by farmers is IDR 10.750. The benefits obtained by the farmers are very small, not comparable to the expenses incurred. Absolute prices formed by availability in the market are not based on adjustments to the cost of production. In certain months when the supply is abundant the price drops dramatically even below the cost of production.

3.1.3 Post Harvest Problem

Some postharvest problems include; (1) inadequate post-harvest facilities and infrastructure facilities, (2) inadequate storage warehouse facilities, (3) conventional drying techniques using 3-4 days of sunlight or hung on *para-para*. This resulted in

tubular damage, weight loss and yield loss up to 35,4% [23]. The results of the mapping showed that many food security supply chain risk assessments were related to microbiological risk assessment, related to the characteristics of food agriculture products [24].

3.1.4 Market Problem

In 2017 the total production of shallots as food in The Majalengka Regency was recorded at 22.249 tons [23]. The population of Majalengka Regency in 2017 recorded 1.260.469 people [23], the average need for shallots was 2,77 Kg/Capita/Year [2]. Thus the need for shallots for the population of Majalengka Regency amounts to 3.541,92 tons/year, equivalent to 16% of the total local production, so there is a surplus of 18.707,08 tons (84%). The product surplus must be channeled out of Majalengka. Currently around 86% of products are intended for traditional markets both locally and outside the region, for a structured market absorbed only around 10%, and for the industrial market around 4%.

3.1.5 Institutional Problem

(a) Institutional Farming

The function of farmer institutions is still not maximal in accommodating farmers with interested parties. Farmers groups have not fully been able to help the activities of its members in developing their farming. The farmer institution function is still focused on production routines, there has been no effort to develop modern competitiveness and marketing.

(b) Indonesian Bureau of Logistics (Bulog)

A few years ago, Bulog had tried to accommodate shallot products, but it did not continue because the prices were not competitive. The price offered by the dealers is higher than the price of Bulog. Also, the storage technology in Bulog's warehouse is still very limited, so it has not been able to accommodate the harvest with good quality.

(c) PT. Mitra Desa Bersama

PT. MDB is a village-level marketing company under the auspices of the Ministry of BUMN. Its role as a driver of the village economy by accommodating harvests and providers of basic needs to be marketed in the form of retail. But now PT. MDB has not accommodated shallot production because there are no standard warehouse facilities. PT. MDB is still focused on the main products of rice and other basic ingredients.

(d) Warehouse Receipt System (SRG)

In 2014 shallots were designated as warehouse receipt commodities. The SRG regulation is regulated in Law No. 9 of 2011. This law was proposed as a solution for farmers who are constrained in obtaining business financing. The SRG was established to the issuance, transfer, guarantee, and settlement of warehouse receipt transactions as well as beneficial for agricultural business groups, especially shallot agribusiness [25].

The SRG helps shallot farmers who in general (1) do not have collateral, (2) low access to finance, (3) limited information on prices and demand, (4) low bargaining position, (5) requires support for working capital liquidity. SRG can be used as collateral or received as proof of delivery of goods to fulfill derivative contracts that are due, as happened in futures contracts. The SRG facilitates the provision of business loans with inventory collateral. In the SRG, financing that can be accessed by goods owners does not only come from banks and non-bank financial institutions but also investors through warehouse receipt derivatives [26].

Warehouse receipts in Majalengka Regency began to be activated in 2018, but currently are still focused on rice products, because they do not have standard technology for the shallot storage process. At present, the storage of shallots still uses conventional warehouses with a risk of shrinkage of approximately 30-50% in 3 months.

(e) Bank Financial Institutions

The bank issued a financing scheme through the People's Business Loans (KUR) program. Payment is made at harvest at 3% interest. Collateral used includes land or building certificates. The bank also facilitates the making of certificates of land and buildings that will be used as collateral. However, some farmers are still unfamiliar with obtaining access to finance because they are still oriented towards traditional markets. Institutionally, the institutional functions of the farmer have not run optimally so that the banking sector is still hesitant to extend loans to the farmer groups.

(f) Bank of Indonesia (BI)

BI plays a central role as a Regional Inflation Control System, thus its activities are to carry out programs to stabilize the prices of strategic commodities in the community. BI's efforts related to shallot agribusiness include conducting sustainable agriculture training, field schools, workshops, assistance with agricultural equipment,

and improving road access. BI also has an agenda for organizing local product bazaars, including shallots. However, these activities are conducted only at certain events, hence the total absorption of shallots products at these events is still very small.

(g) Extension Agents

Extension agents are tasked with carrying out technical guidance to groups of farmers in the target area. However, the role of extension agents is still tended to be in agroproduction techniques. For the marketing of yield, most farmers do it conventionally, namely selling to collectors and dealers. Prices obtained are often not following the production costs incurred, particularly during the harvest season.

(h) Ministry of Agriculture

The Ministry of Agriculture's policies includes; the development of one of the shallot cultivation centers is in the Majalengka region. The Ministry of Agriculture also made a breakthrough in overcoming the turmoil of food prices, namely through the activities of Community Food Business Development (PUPM). PUPM activities are a government effort to maintain supply stability and strategic staple food prices, marketing distribution chain integration to be more efficient, better transmission of prices between consumers and producers, market information between regions is going well, preventing Patron-Client occurrences (food imports into the market of a region may only be supplied by certain business actors), and prevent abuse of market power by certain business actors [27].

The PUMP includes two elements, namely the Community Food Business Institution (LUPM), namely the farmer group as the provider of shallots and the Indonesian Farmers Shop (TTI) as an absorbent party on shallots. Both parties agreed on a work contract and price contract at the start of activities [27]. TTI stipulates a shallot quota of 35 tons/year per farmer group, this quota is only a small portion of the stock of shallots in farmers. The price contract, which initially amounted to Rp. 20.000/kg is now decreasing in the range of Rp. 15.000 to Rp. 18.000, adjusting to the price formed in the wholesale market.

(i) Agricultural Technology Research Institute (BPTP)

BPTP acts as an actor in implementing the dissemination of cultivation technology. One of the technologies that have been disseminated is True Shallot Sheed technology which produces "Double Fold Production" shallot. This technology is very suitable to answer the needs of seeds that are very expensive. However, the technology tested has failed due to inadequate technical factors, so it is discontinued.

(j) Universities

Several universities involved in shallot supply chain networks such as Majalengka University plays a role in the development of technological and socio-economic research, Padjajaran University facilitates the formation of a structured market by bridging marketing between farmers and PT. Kapalindo as a supplier of shallots to supermarkets such as Giant. However, the products absorbed are still on a very small scale, far from the number of shallot products available so far.

(k) Seed Inspection and Certification Center (BPSB)

BPSB is in charge of providing nursery training and seed certification. BPSB guarantees the quality of seeds from breeder farmers through the supervision of seed certification. The dominant role of BPSB for highland farmers is through routine guidance and supervision. The majority of farmers have been able to produce the seeds that are used by themselves or marketed outside the region. The opposite condition occurs in lowland farmers, most farmers do not produce their seeds but buy from outside the Majalengka area. Farmers spend very high production costs due to buying imported seeds. High production costs will reduce farmer profits and become an endless problem.

(l) Shallot Association

The shallot farmers of the Majalengka region have not been registered as members of any shallot association. The relationship between farmers and associations is informal, for example, farmers in the Cijurey region have marketed their cultivated seeds to the association without any MoU. Seed marketing is carried out on a small scale, not routine and does not represent the institution.

(m) Home Industry

Processed products are limited to fried shallot products. The home industry entrepreneurs are still relatively small with the pattern of an individual business.

3.1.6 Process Problem

Most of the shallot farmers have not applied cultivation according to GAP, hence the quality and quantity of production have not been following the standards of structured market demand. Most

farmers only sell their products to collectors or dealers.

3.2 Structured Problems

Structured problems are illustrated in a rich picture. A rich picture is useful to see the relationship pattern of the actors involved. The things that must be included in the rich picture are parties involved in the conflict, the structure, and processes that occur as well as the problems between the parties [21].

3.2.1 Rich Picture Design

A rich picture is commonly used on SSM to show the considered problems of the real world. Researchers can convey a problematic situation more freely through images, lines, marks, or special icons to illustrate a thorough and comprehensive situation [14]. Rich picture showing the problematic situation of the shallot supply chain can be seen in Figure 3.

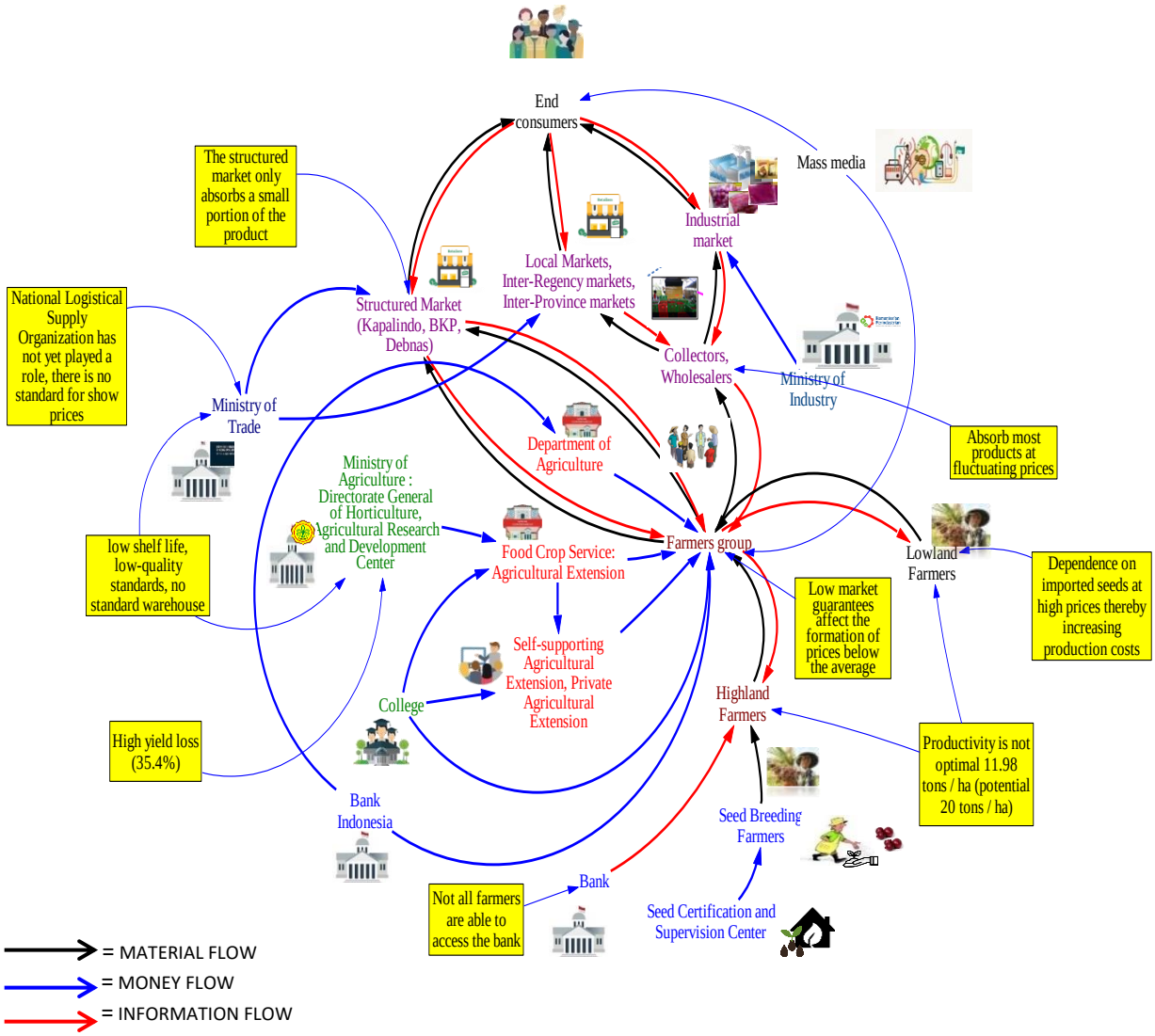

Figure 3. Rich Picture of Shallot Supply Chain System in Majalengka Regency

The rich picture shows the relationship between stakeholder and problem occurred in the innovation system of shallot supply chain, which can be presented in Table 1.

Table 1. Rich Picture Description on Innovation System of Shallot Supply Chain

No	Agent	Actor	Innovation Type	Description
1	Production	Farmer/Farmer group	Product	Some medium to high land farmers can self-sufficient seedlings, even supplying to the other regions. Lowland farmers need a lot of seedlings from the outside because of: -More practical -Lower failure risks -Consideration of better quality of seedlings from the outside
		Collective seller, Wholesaler		Dominantly sell the Shallot in the market
		Traditional/Central Market		Accommodates most shallot products
		Structured Market	Market	Accommodates a small portion of shallot products
		Industrial Marker	Product	Producing Shallot as a processed product, which is limited to fried shallot products. The home industry is still relatively small and individual ownership
2	Supporting	Ministry of Agricultural Affair	Market Product Technology	1. Shallot culture center development (General Directorate of Horticulture Affair) 2. Culture technological dissemination (BPTP) 3. Marketing cooperation as *Toko Tani Indonesia* program (BKP)
		Ministry of Trading Affair	Market	Involved in regulating trade and distribution
		Ministry of Industrial Technology Affair	Technology	Involved in processing technology
		Regional Government: Department of Agricultural Affair, Plant food Affair, Agricultural Guidance Affair, input supply center	Organized processing technology	1. The Department of Agriculture Affair accepts cooperation with various parties for the development of Shallot agribusiness along with the Ministry of Agriculture, Provincial Government, Bank of Indonesia, input supply center, and Higher Education 2. The Food Crop Service provides Agricultural Extension as information source and farmer assistants in Shallot agribusiness
		Bank of Indonesia	Technological process	Bank of Indonesia acts as a Regional Inflation Control System, thus stabilizing the strategic commodity prices. Activities include the development of Shallot clusters, agricultural machines and tools, and organic culture training
		Bank	Process	1. Credit access assistant 2. Facilitates the certification of land and building used for rent
		Higher education	Market technological process	1. Study cooperation with the regional government 2. Culture and processing technology guidance 3. Structured market access guidance
		National Shallot Center	Market	Market access guidance (small scale)
		Agricultural guidance and certification of seedling	Technology	Ensures seed quality from breeders through monitoring of seed certification and issuing labels
		Seedling breeder farmer	Product technology	Provides qualified seedlings
3	Influencer	Consumer	Product	Determines the producer preference of Shallot
		Media	Process	Delivers information and issue from producer to consumer on the supply and preferences, resulting in transparent information

Source: Data result, 2019

Based on the rich picture design, there are several potential problems occur in the Shallot supply chain innovation system. These issues are (1) Dependence on outside seedlings at high prices, resulting in increased production costs; (2) In optimum productivity with only 11.98 ton/ha (potential result should be 20 ton/ha); (3) Low preserve and quality standards, as there is no standard warehouse; (4) High yield loss rate (35.4%); (5) No product price standard; (6) Low market guarantee, thus affecting low average price formation; (7) Structured markets only absorb a small portion of the product; (8) Traditional markets absorb most products at fluctuating prices; (9) Limited ability of farmers to access capital through bank. R*ich picture* analysis result was organized as the main issues and problems hampering the innovation system of the shallot supply chain, as presented in Table 2.

Table 2. Problematic issue and potential impact in the innovation system of Shallot supply chain

No	Issue	Problem	Potential Impact
		PRODUCTION	
1	Expansion of planting area in the framework of special self-sufficiency causes the production average to increase, however, the availability still fluctuate throughout the year	1) Planting depends on the water condition 2) Minimum production month existed 3) Production surplus existed	1) Farmers are unable to plant every year 2) Product price becomes higher on the consumer side 3) Product price becomes lower below the main production cost
		TECHNOLOGY	
2	High production cost because of the input seedlings cost	1) Most seedlings come from the outside region 2) Microclimate which is unsuitable to produce seedling 3) Low farmer capabilities in producing seedlings	1) High production cost 2) Individual seedlings effort failure 3) Farmers depend on the outside seedlings
		ORGANIZATION	
3	General companies of Logistic Affairs does not have any roles on the product absorption	1) The product does not have standard quality 2) The product falls in the market 3) Product price controller is unavailable	1) Product is difficult to enter the structured market 2) Product price occurred does not have the specific reference and imbalance with the production cost 3) Annual fluctuations price occurred
		MARKETING	
4	Low Market guarantees	1) Structured market demand is 10% of the total production 2) Local market demand is 16% of the total production 3) The industrial market is about 4% 4) The rest is 70% coming from the traditional market of the outside region	1) The selling price obtained from the structured market is not significant with the results of farmer production 2) Surplus production 3) The undeveloped home industry of Shallot 4) Price produced is taken from the main market objection
		SOCIAL	
5	Farmer group does not function the as business unit	1) Farmer activities are only focused on the production without increased added value 2) Farmer group is not the cooperation agent and business unit	1) Very low added value product 2) Farmer group member does not have motivation in increasing the added value product
		PROCESS	
6	Culture process does not apply GAP	1) Unmaximized quality result 2) Unmaximized quantity result 3) A high rate of loss result	1) Product is difficult to reach the structured market 2) Unmaximized income 3) Inefficient distributional process

Source: Data result, 2019

3.2.2 Problem Transformation Process

Root definition design is created as the basis for the conceptual model compiled with PQR formula [28]. This is in line with [29], who stated that the root definition describes the system for modeling system. PQR formula comprises: Do P, by Q, in order to help R. This formula will answer what, how and why in the studies. Root definition is tested and refined with CATWOE analysis tool (C = customer, A = actors, T = transformation, W = worldview, O = owners, E = environmental constraint). The Root definition and CATWOE are the sources of activity creations on the purposeful activity model for the shallot supply chain system.

The most relevant system to fix problems as presented on the rich picture is with CATWOE by analyzing the transformation process. Compiled

transformation system is made to fix the six acquired issues as follows:

(a) Lack of irrigation support infrastructure to ensure production stability throughout the year
(b) There has been no ongoing monitoring for the individual seedling production, especially for the characteristics of the lowland area in Majalengka
(c) There is no special institution serves as a product absorbent, standard product quality guarantee, and price stability regulator
(d) Decreased value-added product at the group level as well as farmer training as a joint venture and business unit
(e) No GAP Shallot training for farmers who can guarantee the quality and quantity of products to the structured market

The next transformation statement is built into a "relevant system" to formulate the root definition. Relevant systems built include:

(a) The system that provides support for production infrastructure in the form of irrigation to ensure production stability throughout the year
(b) The system that provides continuous coaching for the production of seedlings/seed independent especially for the characteristics of the lowland area Majalengka
(c) The system for special institutions that serve as product absorbent of the product, the standard guarantee of product quality and price stability
(d) The system that provides continuous improvement of value-added product at the group level as well as training for farmer and vehicle for cooperation as well as business units
(e) The system that provides GAP of Shallot culture for farmers, who can guarantee the product quality and quantity to the structured market based on the *relevant system*, which will be built into five *root definitions* as follows:

Root definition 1:
"The existence of a system that provides support for production infrastructure (P) through institution coordination related to the support of irrigation facilities and infrastructure (Q) to ensure production stability throughout the year (R)"

CATWOE Analysis

Customer (C)	Farmers and other communities who benefited from the system
Actor (A)	The system will be built, operated and managed by farmers. The Government of the relevant service plays a role in fulfilling the needs of production facilities and infrastructure, especially irrigation and management training for farmers.
Transformation (T)	Farmers can plant shallot anytime without considering irrigation problems. The system will guarantee water availability to ensure production stability. System changes will create a stable supply of Shallots and better output
Worldview (W)	A belief that the system will provide the potential to improve production fluctuations, productivity, quality, and value.
Ownership (O)	The system will be owned by farmers and village organizations.
Environmental constraints (E)	Support change will emerge from farmers perpetrators, regional development agencies, department of irrigation process. Resistance changes will come from farmer's who stay afloat with the planting pattern that is during this run.

Root definition 2 :
"The system that relates farmers and related institutions such as PPL, BPSB, BPTP and Kiosk Saprodi (P) by providing coaching and continuing training on the seedling breeding technology (Q), thus producing individual Shallot seedlings especially for the lowland area characteristic (R)"

CATWOE Analysis

Customer (C)	Farmers and other communities who have benefited from the system
Actor (A)	The system will be built, operated and managed by farmers. PPL plays a role in mentoring the technological application, BPSB has the role in the monitoring and evaluation of seedling production, BPTP plays a role in implementing dissemination and cultivation technology, technical training and continuous coaching. All three actors play a role in achieving the farmer individual seedlings who will run the daily system
Transformation (T)	Farmers can produce seedlings independently but later can produce TSS seedlings. This system will guarantee the seed availability independently for production cost efficiency. System changes to minimize the cost of Shallot production and maximize income cost
Worldview (W)	A belief that this system will give

	the potential for the individual seedlings. The system can minimize production costs and maximize the income
Ownership (O)	The system will be owned by farmers, supplier seedlings
Environmental constraints (E)	Changing support arises from farmers, PPL, BPTP, and BPSB. Resistant changing come from farmers who remain to survive the use of imported seedlings and seed supplier

Root definition 3 :
"The existence of a system that coordinates between farmers and markets (P) through a special institution serves as an absorbent production (Q), as well as a guarantor of product quality standard and price stability control (R)"

CATWOE Analysis

Customer (C)	Farmers and other communities who have benefited from the system
Actor (A)	The system is built, operated and managed by farmers. PPL plays a role in mentoring each process, Logistic affair plays a role in absorbing production results, setting the standard market price, and regulating the market balance.
Transformation (T)	Re-active the logistic affair function and its derivatives as a strategic absorbent agricultural product to maintain market balance. The system will ensure the absorption of excess production and maintain the stability of product prices in the market and ensure the price received by farmers
Worldview (W)	A belief that this system minimizes the marketing risk of Shallot. The system can also keep the price stability formed in the market
Ownership (O)	The system will be owned by farmers, intermediary traders, and consumers
Environmental constraints (E)	Changing support will arise from farmers, logistics, SRG, and other partnerships. Resistant changes come from farmers who stay afloat with conventional marketing patterns and brokers who are accustomed to accommodating farmers products at the volatile price

Root definition 4 :
"The system that develops the farmer group (P) through training for increasing value-added products sustainably and developing the farmer group as a joint venture and business unit (Q), thus increasing the farmer income and welfare (R)"

CATWOE Analysis

Customer (C)	Farmers and other communities who have benefited from the system
Actor (A)	The system will be built, operated and managed by farmers. PPL plays a role in process mentoring, higher education and BPTP play a role in the development of research and technology partner, the market plays a role in determining the desired preference price
Transformation (T)	The development of farmer group as a vehicle for the cooperative business unit through increased value-added product training and business networking
Worldview (W)	The system will improve the function and role of farmer group and the innovation process. The system can also make the farmer groups as a business and economic unit to increase the income and welfare of its members
Ownership (O)	The system will be owned by farmers, cooperative partners, and *BUMDES*
Environmental constraints (E)	Changing support will emerge from breeders, cooperative partners, and *BUMDES*. Resistant changes will come from farmers who stay with the old business pattern selling primary products, thus making barriers derived from large-scaled business competitors

Root definition 5 :
"System that can bring farmers to the GAP culture based (P) through GAP training (Q) to ensure the quality and quantity of product at the structured market (R)"

CATWOE Analysis

Customer (C)	Farmers and other communities who benefit from the system
Actor (A)	The system is built, operated and managed by farmers. PPL play a role in conducting process mentoring. Higher education, BPTP, agricultural department, national companies, and Bank of Indonesia are instrumental in the research development, technology partner, and dissemination of the cultivation process according to GAP. Consumers determine the desired preference product
Transformation (T)	The growing product of conventional products into sustainable products based on an economic, technical, social, and environmental part, thus the product has good competitiveness and market share
Worldview (W)	The system will make farmers accustomed to the culture process according to GAP and improve the innovation process. Furthermore, the system can make the farmer group as a business and economic unit to increase the income and welfare of its members
Ownership (O)	The system will be owned by farmers, structured market, and consumers
Environmental constraints (E)	Changing support will arise from farmers, community leaders, structured markets, and consumers. Resistant changes will come from farmers who stay with the old business pattern that ignores sustainability factors, having barriers derived from large-scaled business competitors

3.2.3 Dynamic Model from Problematic Situation through System Thinking Design

The development of the common model becomes a cause-for-effect diagram used as an effort to understand the clustering complexity of Shallot based on components presented in the general model and will be a limitation on the Causal Loop Diagram system.

CLD is a systems-thinking approach that recognizes interdependent and relationship of elements in a system [18]. Custom behavioral patterns can be described as a unique system structure represented by CLD [30]. In the paradigm of thinking systems, the polarized causal relationship is depicted using an arrow at the end of the sign marked as positive (+) or negative (-). Positive mark means the cause will add to the result or cause will affect the consequences in the change direction. If the cause increases (or decreases), the consequences also increase (or decrease vice versa). Negative mark means the cause will reduce the consequences or cause affects the consequences in the opposite direction. The opposite direction means whether the cause increases (or decreases), its effect on the consequences will be the opposite.
The blue loop is a problem in the real world, while the red loop is a solution plan that will be simulated.

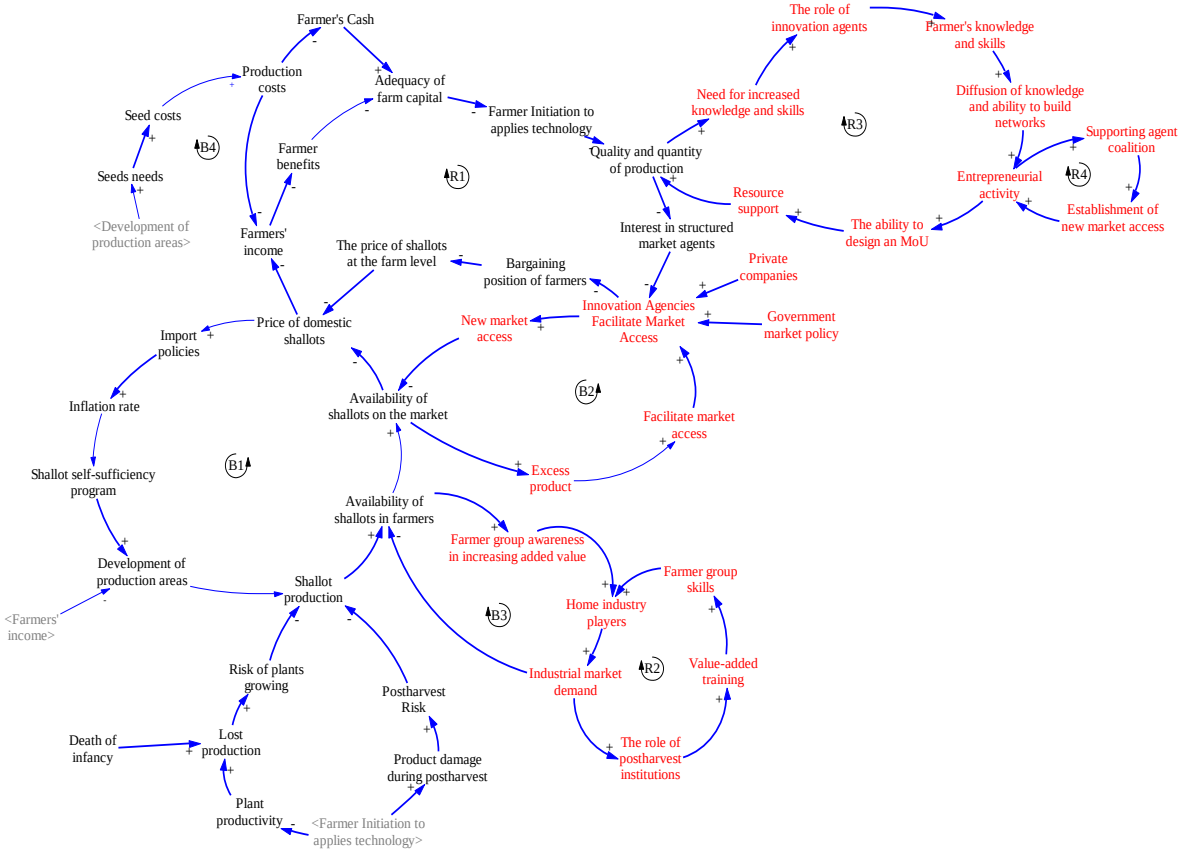

Figure 4. Causal Loop Diagram of Shallot Production Innovation System in Majalengka Regency

CLD diagram starts from the production system symbolized as *Loop B1*; the high price of domestic shallots in the past few years has triggered import policies. Imports increase inflation, so the government tries to stop imports with production policies. Investment increases, production increases, so domestic prices fall.

Loop R1; Domestic shallot prices fall, resulting in farmers' decreasing profits and income. The lack of farm capital adequacy results in farmers' low initiative to implement technology so that the quality and quantity of yields decline, which has an impact on the decline of the structured market demand. The bargaining power of farmers has declined.

Loop B2; Abundant availability of shallots results in a product surplus that requires the facilitation of new market access. The expectation is to open access to new structured markets so that production surpluses can be handled well.

Loop B3; Product surplus can be an opportunity for farmer groups to increase product added value. The number of home industry players increased, and the products demand the industrial market increased and eventually became a surplus production solution.

Loop R2; Industrial market demand causes an increase in the role of the Micro Small and Medium Enterprises Office and the Post-harvest Research Center on yield processing technology. Efforts were made through training programs to increase the added value of products to improve group skills. Thus, the number of home industry players increased, and industrial market demand increased.

Loop B4; planting shallots increases the need for seedlings and production costs. As a result, farmers' income and profit declined. The lack of capital adequacy results in the low initiatives of farmers to apply technology so that the product quality and quantity decline, and the interest of structured market agents also declines. Domestic shallot prices are going down, farmer acceptance is declining, and as a result, the planting motivation is decreasing.

Loop R3; the demand for quality and quantity of production adds to the need for increased knowledge and skills and thus requires an increase in the role of creator agents and innovators. The learning process will improve farmers' knowledge and skills, and there is a diffusion of knowledge and the ability to build cooperation networks, so that entrepreneurial activity increases. The ability of farmers to draw up an MoU with other parties has also increased. These activities increase the support of resource allocation from various relevant agencies and will ultimately increase the quality and quantity of production output.
Loop R4; entrepreneurial activities increase the supporting agent's role, including marketing agent is to increase the opportunities for the formation of new market access. Newmarket access will motivate more entrepreneurial activities.

4. Conclusions and Recommendations

Situation conditions in Shallot's supply chain innovation system show that the fundamental problems faced; Lack of support for production infrastructure in the form of irrigation throughout the year; There is no ongoing training for breeding bulb seeds; There is no specific institution that functions as a product absorber, guarantor of standards on quality and price stability; There is no ongoing training on value-added products as vehicles for cooperation and business units; There is no Good Agricultural Practice (GAP) training that can guarantee the quality and quantity of products to a structured market. Relevant systems that can be built include; Systems that provide support for production infrastructure, especially irrigation networks; System that provides training for breeding bulb seeds; The system for specialized institutions serves as a product absorber, guarantor of standard product quality, and regulator of price stability; Systems that provide ongoing training in value-added products as a vehicle for cooperation and business units; and system that provides GAP training of shallot culture to ensure the quality and quantity of products to a structured market.

CLD results in an innovation system framework illustrate the real-world situational flow and problem-solving plan as a continuation of CATWOE analysis. In summary, it can be concluded that shallot production faces various risks, namely the risk of the impact of development policy on production areas on supply and demand, production risk, post-harvest risk, and market risk which have an impact on high production costs and reduced income for farmers. The problem-solving plan, among others, is to improve farmers' knowledge and skills in terms of production, postharvest, yield processing, and the ability to build networks. To achieve this, innovation actors such as research institutes, universities, financial institutions, structured markets, and government must be involved and coordinated within an innovation system framework. Dissemination of innovation will increase entrepreneurial motivation, foster investor interest, expand market networks, manage resources, increase research and development activities which in turn become a sustainable innovation cycle.

The novelty of this paper can be found in terms of content and methodology. This study analyzes the situation of the agrifood sector holistically from upstream to downstream in the framework of the innovation system. The study also combined the soft system methodology (SSM) and the system dynamics (SD) into the soft system dynamics methodology (SSDM) that can clearly distinguish between Problem Solving System and Problem Content System. This paper contributes to describing the detailed and holistic situation through the feedback mechanism that emerges from the CLD. Our study suggested further research exploration that is steps of modeling to observe the behavior of the real-world and after an intervention scenario in the shallot supply chain process.

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