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SUSTAINABLE VALUE OF RICE SUPPLY CHAIN: A SYSTEMATIC LITERATURE REVIEW AND RESEARCH AGENDA

NILAI BERKELANJUTAN RANTAI PASOK BERAS : TINJAUAN SISTEMATIS LITERATUR DAN AGENDA PENELITIAN

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ABSTRAK

Rantai pasok beras merupakan kunci pencapaian ketahanan pangan. Berbagai perspektif, tantangan atau issue yang terkait dengan penyediaan kecukupan pangan pokok, pengelolaan inventory, terfragmentasinya distribusi, keterjangkauan akses dan harga, banyaknya variasi proses bisnis dan timbulnya dampak lingkungan dari sistem produksi dan logistik menyebabkan rantai pasok beras masuk kedalam permasalahan system yang komplek. Tujuan penyusunan artikel systematic literature review ini adalah mengidentifikasi permasalahan rantai pasok beras saat ini sebagai dasar pengembangan upaya penyelesaian dengan pendekatan terintegrasi dan peningkatan nilai rantai pasok beras. Sebanyak 50 artikel fokus pada tema rantai pasok beras. Sisa artikel yang lain membahas kontribusi penelitian dalam peningkatan produktivitas padi, tingkat optimasi persediaan, peningkatan kinerja dan ketelusuran. Hasil review pada vos viewer menunjukkan sustainability terkoneksi dengan rantai pasok pada posisi yang jauh yang menunjukan sustainability berpeluang untuk diteliti lebih dalam pada future research. Analisis gap menunjukkan peningkatan produksi pada existing research terbatas pada inovasi di bidang agronomi dan belum melihat input dengan karakteristik berkelanjutan. Aspek inovasi non teknis yang menggunakan teknologi informasi untuk pertanian presisi juga belum dikolaborasikan secara komprehensif. Pada existing research juga belum ditemukan optimasi persediaan dengan mempertimbangkan penyerapan produksi dan belum dikembangkan sistem ketelusuran yang terkait ketersediaan pasokan. Upaya dari aktivitas di atas akan mentransform kinerja rantai pasok yang efisien, responsive dan meminimalisasi dampak lingkungan sehingga meningkatkan nilai keberlanjutan rantai pasok beras

Kata kunci : analisis gap, integrasi, keberlanjutan, rantai pasok beras, sistem produksi dan logistik

ABSTRACT

The rice supply chain is important to achieve food security. It has various perspectives, challenges or issues that causes a complex problem in supply chain system. The existing problem are related to food availability, inventory level, fragmented distribution, affordability of prices, accessibility, variation of business processes and the environmental impact from production and logistics system. Moreover integration framework in the dimension of sustainability is limited. The objective of this article is to identify current problems to construct the idea of supply chain integration and to build the formulation for improvement the value of rice supply chain. Fifty articles discuss rice supply chain. The remaining discuss on increasing rice productivity, inventory optimization, performance improvement, and traceability. The VOS viewer result showed that sustainability is connected to the supply chain at a distant position which indicates that sustainability has the opportunity to be studied wider range in future research. The gap analysis showed that the production increase is limited to agronomy innovation and didn’t consider sustainable characteristics input. The indirect innovations that use information technology for precision farming also had not been comprehensively collaborated. The production absorption had not been considered in inventory optimization and traceability system had not been developed for supply availability. The improvement activities to fill the gap will transform supply chain performance more efficient, responsive and minimum environmental impacts for the enhancement of the sustainability value of the rice supply chain.

Keywords: gap analysis, integration, rice supply chain, sustainability, production and logistics system

INTRODUCTION

The food security approach commonly focuses on production, which aims to increase the food supply by increasing productivity. However, long-term productivity sustainability achievement requires efficient input to minimize the negative environmental impact (Devkota *et al.*, 2022). Yadav *et al.* (2022) also stated that a major challenge of food supply chain sustainability is demand increase which will pressure the use of natural resources, water, energy and land. In addition, the problems faced by

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the food supply chain are complex. Modern analysis of food security give five critical components of challenges in the food supply chain: food availability upstream and downstream, food access affordability to households in remote areas, fulfilment of food security needs, nutritional status and health, sustainability of the food system, and stability (Timmer, 2017). Nurmalina (2017) defines sustainability as the use of resources to meet current needs without sacrificing the meeting of future generations. Sustainability is a complex and multidimensional issue, with a triple bottom line (TBL) approach, which balances the environmental, economic, and social dimensions (Ojo *et al.*, 2020; Kumar *et al.,* 2018). Meanwhile, the integration of sustainability into the supply chain is a growing research interest. Sustainability should be observed as a holistic and interdisciplinary concept covering environmental, economic, and social issues to enhance the value of supply chain.

Rice is a staple food in Indonesia. Therefore it has a significant role in Food Security achievement. The stability of food security is the success of integrating of supply chain business processes from upstream to downstream (León-Bravo *et al.,* 2017; Aji 2020) According to Jakkhupan *et al.* (2015) Supply chain is a system of organizations, people, technology, activities, information, and resources involved in moving products or services from suppliers to customers. This includes material, information and financial flows. According to Zhou and Benton (2007), the supply chain is an integrated system; therefore the point of view of the supply chain analysis must be comprehensive.

Supply chain optimization is less effective if it is carried out in partial scope for solving problem at one stage. It may be unreliable to be adapted as a whole system upstream to downstream (Stone and Rahimifard, 2018). The yield increasing in upstream will increase rice availability at the level of supply chain actors that impact performance transformation and inventory optimization to minimize costs and maximize distribution for consumption needs.

The long supply chain involves many intermediaries and no market information disclosure, especially for farmers and consumers as price takers. According to Wahyono *et al.* (2009) and Purwandoko *et al.* (2019a), the problem is information asymmetry and distortions among stakeholders. Improper management of information cause a 'Bullwhip Effect' i.e. variability of inventory planning and forecasting at various levels of the supply chain, which can lead to overstock or out-of-stock (Sharma *et al.,* 2013). Traceability development could be solution to the issue. Furthermore, the objective in the literature review is to identify current problems to construct the value of supply chain sustainability with integration approach.

RESEARCH AND METHODS

A research question is a systematic question to search literature reviews using research keyword to identify problems, and how to address the problem integratedly. Literature Review aims to collect all materials related to research topics that have been studied and as a support to identify gaps as the basis for further research. The Research Questions (RQ) for the Sustainable Supply Chain of Rice are

1. What is the current issues of rice supply chain and how the relation to sustainability value?
2. What innovations have been developed to increase productivity and how to predict it?
3. What is the optimization model for stock optimization?
4. How to measure of the rice supply chain performance ?
5. What the development of rice supply chain traceability ?

PRISMA Diagram Literature Review

A number of sustainable supply chain article employed PRISMA (The Preferred Reporting Items for Systematic Reviews and Meta Analysis) to report systematic literature review (Utomo *et al.,* 2018; Adelodun *et al.,* 2021; Nadaraja *et al.,* 2021; Bux *et al.,* 2022; Li *et al.,* 2022). PRISMA is a method to report systematic review. Systematic reviews is a review that uses explicit, systematic methods to colate and to synthesise findings of studies that address a clearly formulated question. The PRISMA Statement consists of four phase flow diagram (Page *et al.*, 2021; Parums 2021). First step of PRISMA is identification of a large number of article. Articles were identified with keyword through scientific database search engine from general title. There were 635 article in Semantic, 376 in Scopus, 400 in Science, 93 in Google Scholar. The second step was screening by removal duplicate article using mendeley, which remains 1336 article. The next selection was screening 467 article. The eligibility assessment was conducted by identifying specific parameter in Research Question, rice supply chain issue, productivity innovation, stock optimization, supply chain performance, supply chain traceability system and rice supply chain sustainable assessment with the result 166 article, consisting of 133 quantitative and 33 qualitative article.

Literature search comes from 4 sources, such as semantic, Scopus, Science Direct, and Google Scholar. Processing or reprocessing is carried out by Mendeley to remove duplicate articles obtained and filter by title and abstract. The Prisma literature review diagram as showed in figure 1.

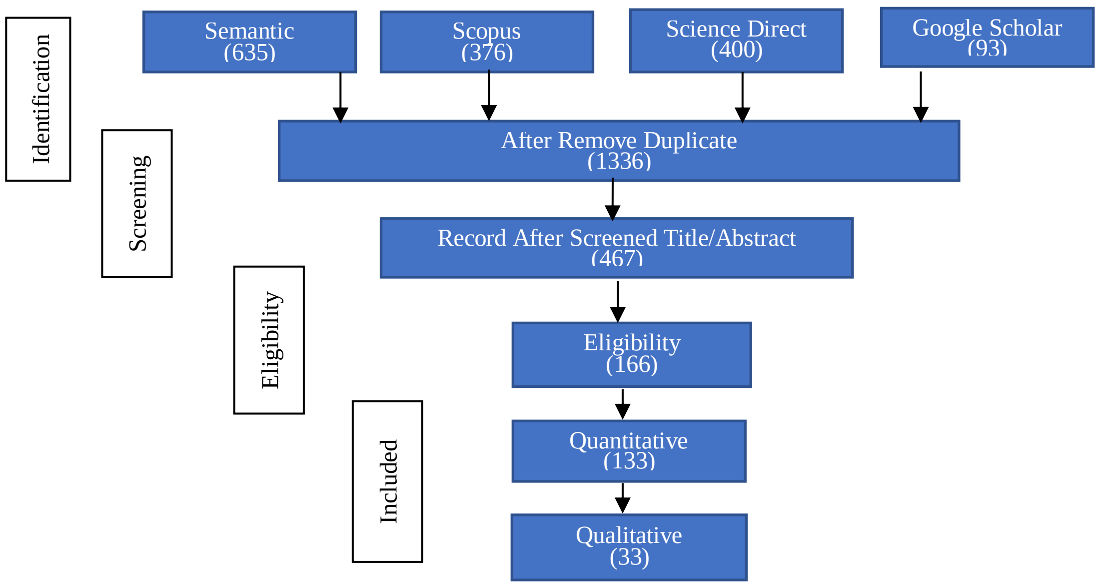

Figure 1. Prisma Diagram of Systematic Literature Review

RESULT AND DISCUSSION

Current Issues in Rice Supply Chain

Research Question 1 is used to describe current issue in Rice Supply Chain. Keywords used to get the article were rice and "supply chain" in the article title and abstract, with result in 55 articles from various countries, which rice is the primary food and a few countries still have food security issues. Most of article include quantitative research (73%) and the remaining is qualitative research. The article was classified into 15 problem scope and 25 research implementations (Table 1). There are 3 problem scopes that most found, namely complex supply chain, supply availability and sustainability awareness. The multi stage supply chain involving many intermediate actors and lack of information exchange cause other issues in complex rice supply chain. Fragmented distribution, unclear stakeholder role, stock and safety issue deliver main reason behind its inefficiency. Majority problem in supply availability is production increase on upstream, however the limited integration bring downstream impact. Research implementation was conducted in order to address these problems, such as performance analysis, supply chain design, traceability, food security analysis, simulation of production and location allocation production.

The sustainability is challenge in food security and food supply chain. The awareness to achieve sustainability value was found in a number of articles that have purpose to analyse impact of sustainability enabler to better future production or environment. Research implementation related to sustainability consist of sustainability assessment, circular production analysis, supply chain design, certified sustainability, comparison of traditional and sustainability farming, and institutional analysis.

Existing Technology Innovation Effort To Increase Rice Productivity And Approach To Predict It

Research Question 2 is used to analyse Approach for Simulation Productivity Increasing based on farming innovation. There are 18 articles found that reveal innovation technology for rice yield increasing. Innovations in increasing production from the productivity aspect are divided into 2, namely direct innovation that has a direct effect of yield increasing caused improved production input and technology directly by applying engineering cultivation to land and plant, consisting of improve rice variety, integrated crop management, integrated farming, planting system and system of rice. A number of research result rice yield increasing from innovation technology improved. Erythrina *et al.* (2021) applied Integrated Crop Management (ICM) in 10 province of Indonesia therefore it increased 1,9 ton/ha rice yield by using specific variety and nutrient as well as irrigation improving. Integrated crop management (ICM) and System of Rice Intensification (SRI) are innovation crop production system that support farming sustainability increasing farmers' yield. Improved rice varieties resulted 76% increase in rice farmers' productivity (Abdul-Rahaman *et al.*, 2021). SRI practices significantly increased the rice yield by 10.9 % compared with current improved practice (Wu *et al.*, 2015). While indirect innovation employ information technology for precision farming that has indirect implication for yield increasing, such as contract farming, cropping calendar, and smart farming. Types of innovation that are classified as direct and indirect can be seen in Table 2.

Table 1. Classification of current issue in rice supply chain

Problem Scope	**Research Implementation**	**Author**
Competitiveness	Benefit and Cost Analysis of Rice Milling	(Chung *et al.,* 2016)
	Value Improvement	(Kpetere *et al.*, 2018)
Complex Supply Chain	Efficiency Performance Analysis	(Anugrah and Wahyuni 2019)
	Performance Improvement	(Wibowo Putro *et al.*, 2022; Moeis and Wibowo 2016)
	Simulation of production impact	(Jamaludin *et al.*, 2021)
	Supply Chain Design	(Perdana *et al.*, 2020)
	Traceability	(Kumar and Iyengar 2017; Purwandoko *et al.*, 2019b)
	Transformation of Rice Industry	(Hossain and Jahan 2018)
	Sustainable Price Analysis	(Suryani *et al.*, 2022)
Distribution Routes	Supply Chain Design	(Nurprihatin *et al.*, 2021)
Drought Prediction	Simulation of production	(Shams Esfandabadi *et al.,* 2022)
Efficiency of Rice Business Process	Collaborative relationship	(Kwon *et al.*, 2016)
	Transformation of Rice Industry	(Lim *et al.*, 2013)
Environment Impact of Paddy Production System	Sustainability Assessment	(Baca-Nomberto *et al.*, 2021)
Food Crisis	Transformation of Rice Industry	(Soullier *et al.*, 2020)
Impact of Covid19	Demand and Supply optimization model	(Chaerani *et al.*, 2022)
	Food Security Analysis	(Ankrah *et al.*, 2021)
Impact of Research Investment	simulation of production	(Pandit *et al* 2020)
Losses	Strategy of Production Optimized	(Kok and Snel 2019; Ortañez *et al.*, 2020; Mesterházy *et al.*, 2020)
Risk of Supply Chain	Benefit and Risk Distribution of E Commerce	(Bai. 2021)
Supplier Selection	Sustainability requirement of Supplier Selection	(Wang *et al.*, 2018)
Supply Availability	Food Security Analysis	(Timmer 2017)
	Simulation of production	(Karmakar *et al.*, 2021; Ngandee *et al.*, 2021; Mahbubi 2013; Arouna *et al.*, 2021b)
	Supply Chain Spasial Analysis	(Yang *et al.*, 2021)
	Location Allocation Production	(An *et al.*, 2021)
Sustainability Awareness	Certified Sustainability	(Connor *et al.*, 2022; My *et al.*, 2018)
	Circular Production Analysis	(Doliente and Samsatli 2021) (Runkle *et al.*, 2021)
	Comparison of Sustainability	(Sharma *et al.*, 2018)
	Institutional innovation analysis	(Singh 2017; Gugkang 2019)
	Integrated Fish Farming	(Li *et al.*, 2021)
	Nitrogen Efficiency Modulation	(Wu *et al.*, 2020)
	Supply Chain Design	(Chauhan *et al.*, 2020)
	Sustainability Assessment	(Moreno García *et al.*, 2021; White *et al.*, 2020; Okpiaifo *et al.*, 2020; Moreno-García *et al.*, 2021; Devkota *et al.*, 2022; Ojo *et al.*, 2020; Arouna *et al.*, 2021a)

Table 2. Type of farming innovation

Type of Innovation	**Innovation Technology**	**Number of Article**
Direct	Improve Rice Variety	1
	Integrated Crop Management	2
	Integrated Farming	2
	Planting System	1
	System of Rice Intensification	4
Direct Total		10
Indirect	Contract Farming	1
	Cropping Calender	2
	Smart Farming	5
Indirect Total		8

In addition, it takes a mapping of the production prediction method used in the research article. From the search for prediction methods, 25 articles were obtained, with the proportion of methods as showed in Table 3.

Table 3. Group of rice yield predicted method

Prediction Method	Number of Article
ANN	5
Image Processing	3
Forecasting	3
Sisdin	3
Support Vector Machine	2
FIZ	2
FIZ vs Regresi	2
ANFIZ	1
ANN Fuzzy	1
ANN vs Survey vs Spasial	1
K nearest Neighbour	1
Regression	1

Approach of Stock Optimization

Research Question 3 is used to explore the stock optimization model in order to fulfil the demand and absorb the supply of rice. The research question resulted 35 articles which were classified into 2, namely inventory optimization by considering safety stock and not considering safety stock. Safety stock (SS) is an extra quantity of inventory which a company holds in inventory to reduce the risk of the item being out of stock (Gupta *et al.*, 2022). Inventory optimization considering either safety stock or non safety stock aim to minimize cost of business process in supply chain. Douaioui *et al.* (2021) and Gebennini *et al.* (2009) used mixed integer linear programming technique with the safety stock parameter to minimize the total cost. The methods used in research related to inventory optimization is showed in Table 4.

Inventory optimization using the EoQ method was studied by Nildawati *et al.* (2018) and Putri *et al.* (2020) at Food Logistic Agency and Mandala and Darnila (2017) at Jasa Tani corporation to determine procurement, inventory reorder levels of rice. Optimization of rice production planning using the goal programming method was studied by Mardliyah *et al.* (2020) to obtain optimal rice production targets *with* minimum production costs and maximum sales profits.

Approach for Supply Chain Performance Measurement

Research Question 4 is used to explore approach for supply chain performance measurement. Based on 24 articles obtained related to the performance of the rice supply chain, there are 5 classifications of the research scope (Table 5). The articles contain correlation of supply chain enable that impact on performance, such as smart technology (Yousefi and Mohamadpour Tosarkani 2022), Green Supply Chain Management practices (Samad *et al*., 2021), operational strategy (Qi *et al*., 2017). While the effectiveness and efficiency performance are in the performance assessment scope (Singh *et al*., 2017; Azfar *et al*., 2014). Few techniques had been proposed to measure supply chain performance, such as SCOR Metric, LCA, and Dynamic Balanced Scorecard. In addition ,most article discuss performance in general product. There are still few articles that discuss rice supply chain performance assessment.

Development of Rice Supply Chain Traceability

Research Question 5 is used to analyse Method and Approach for Rice Supply Chain Traceability. Based on 9 articles obtained related to keywords Rice AND “Supply Chain” AND traceability, there were 4 type of rice traceability research, consisting of rice traceability, rice traceability with IoT Support, rice traceability using blockchain, rice smart contract using blockchain. Every type was constructed by either architecture development or prototype implementation (Table 6)

Table 4. Group of Inventory Optimization Methods

Method	Variety of Method	Number of Article
AI	Deep Learning, Bayes Network-ANN-SVM, AI With IoT	3
Mathematic Model	Algorithma Differential Evolution, Forecasting & Mathematic Model, Fuzzy Optimization Algorithms	10
Heuristic	GA, Silver Meal Heuristic	3
OR Technique	Dynamic Program, MILP, MILP Fuzzy, Goal Programming	5
Others	EOQ, Kualitatif, 3IC, Lot Sizing, AHP, Continues Review System, Prototype Development, Benders decomposition technique, Forecasting	14

Table 5. The methods used in supply chain performance analysis

Scope	Method	Number of Articles
Performance Driver Analysis	Conceptual Analysis, FIZ, Natural Resource-Based View (NRBV), System Dinamik, AMOS Analysis, Coarsened Exact Matching (CEM) and a Difference-In-Difference (DID) analysis, SEM, Statistic Deskriptive & Regression	12
Performance Assessment	Dynamic Balanced Scorecard, SCOR Metric, LCA, Conceptual Analysis	6
Performance Impact on Sustainability	Conceptual Analysis, SEM	4
Risk Mitigation Strategy	DEA	1
Performance Indicator Analysis	Conceptual Analysis	1

Table 6. Group of rice traceability based on development scope

Type of Rice Traceability Research	Development Scope	Number of Article
Rice Traceability	Prototype Implementation	1
	Architecture Development	3
Rice Traceability with IoT Support	Prototype Implementation	1
	Architecture Development	1
Rice Traceability Using Blockchain	Architecture Development	2
Rice Smart Contract Using Blockchain	Prototype Implementation	1

Vos Viewer Analysis

The literature selected from PRISMA is analyzed by Vos viewer to recognize research trends generally for gap opportunities.The Cluster analysis of the entire literature collection RQ 1 to RQ 5 is showed in Figure 2 and overlay analysis of the entire literature collection RQ 1 to RQ 5 is showed on Figure 3.

There are 4 clusters of green, blue, red, and yellow. The center of the blue color is the supply chain, which is connected with term points in other clusters. In the blue cluster, the supply chain is connected with performance, risk, resilience. The supply chain is connected with sustainability, food safety, and traceability in the green color cluster. These terms were also emphasized in literature review based on research question by Timmer (2017) and other authors. The authors mention that these terms is challenge in agriculture food supply chain toward resilience food security. The supply chain is connected to the system in main center of red cluster which connects the production elements in the cluster itself and key elements in other clusters. The model as center term of yellow cluster was connected to the term of demand, order, quantity, and inventory.

The color of the supply chain is in the range of the 2018 to 2021. The supply chain has many links to other terms. Dark blue is terms in under 2018. Gradually, the brighter show new terms that are connected to the supply chain. The yellow color shows the renewal of research themes that carry sustainability, traceability, blockchain, emission, energy, profit, uncertainty, and covid.

Density analysis of the entire literature collection RQ 1 to RQ 5 is showed on Figure 4. The fading yellow with the farthest position have an opportunity to propose new research themes in the supply chain field, which there are still so many elements that can be explored in these terms, including traceability, productivity, inventory, sustainability and integration. These terms also relate with main keyword in research question, so that the research gap and future research will consider them.

Green Rice Supply Chain of Indonesia

The national rice supply chain system consists of supply, production and consumption (Mahbubi, 2013). The national rice supply chain depends on the paddy productivity in supply side. However the current productivity is lower than the potential productivity. The yield potential of new superior varieties on the research scale can reach 7-8 tons Dried Milled Grain/ha (Kementan, 2022), however the productivity average reaches 5 tons/ha of Dried Milled Grain (BPS, 2022). National rice productivity can be improved by farming technological innovations that released by Indonesian Agency for Agricultural Research and Development, university and other institutions. The new superior varieties is part of integrated crop management cultivation techniques in accordance with the principles of Good Agriculture Practices.

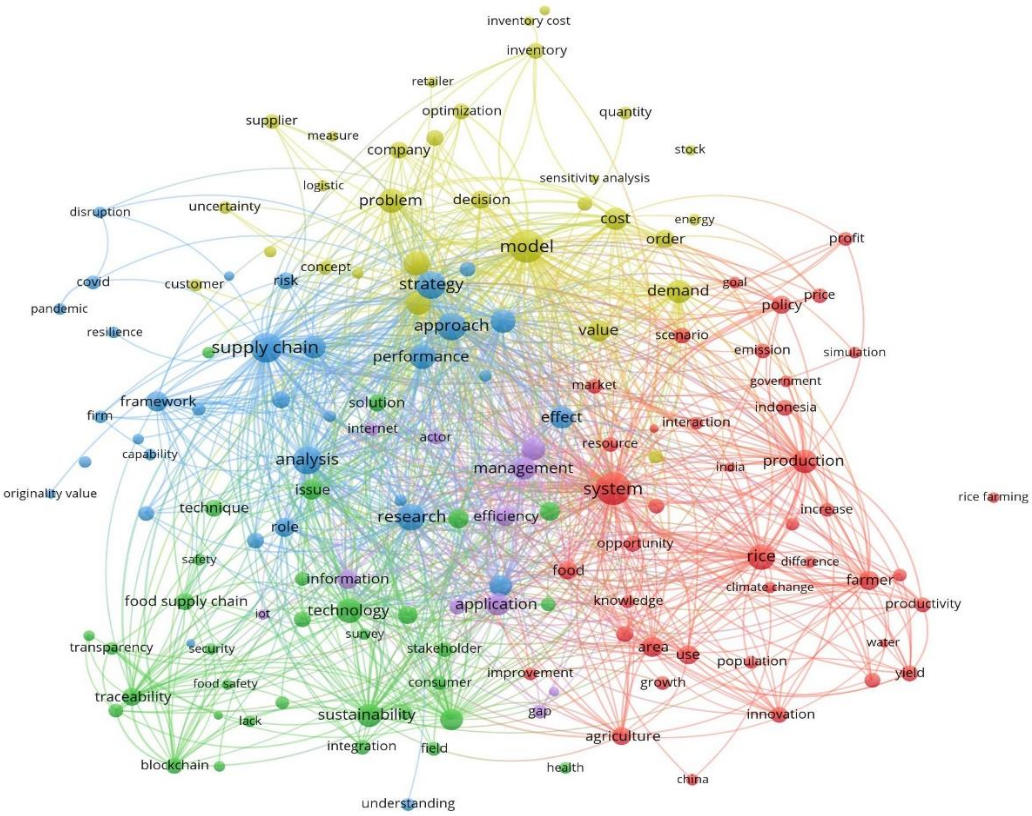

Figure 2. The cluster analysis of literature review

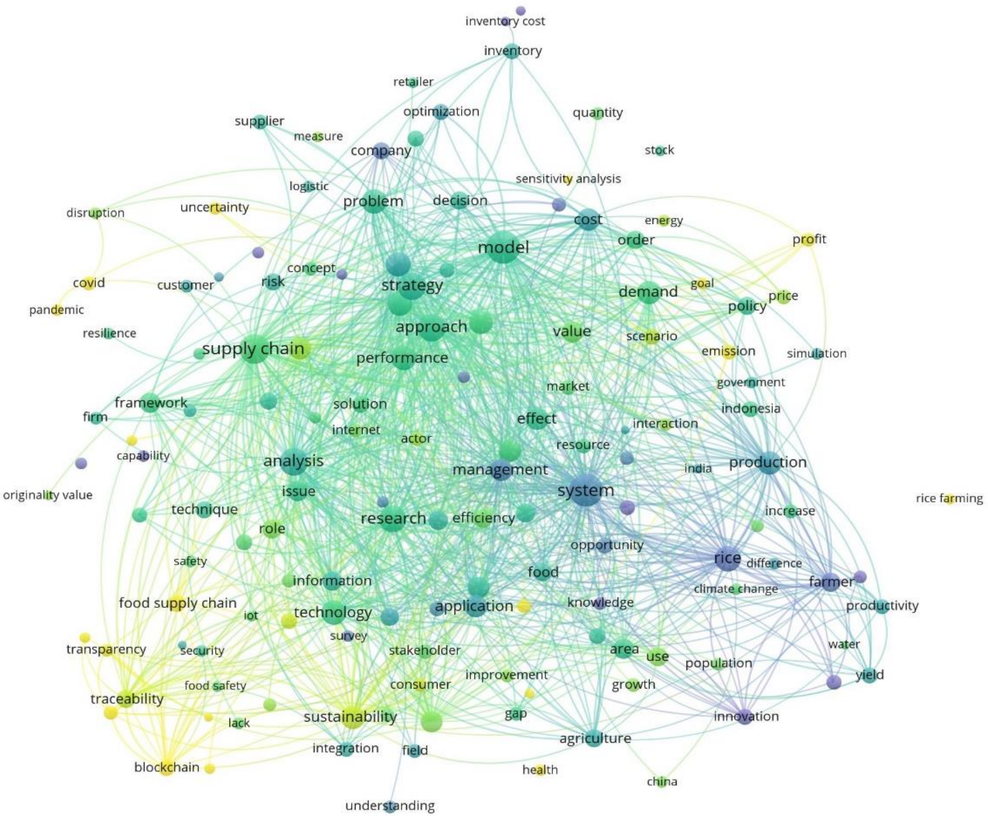

Figure 3. The overlay analysis of literature review

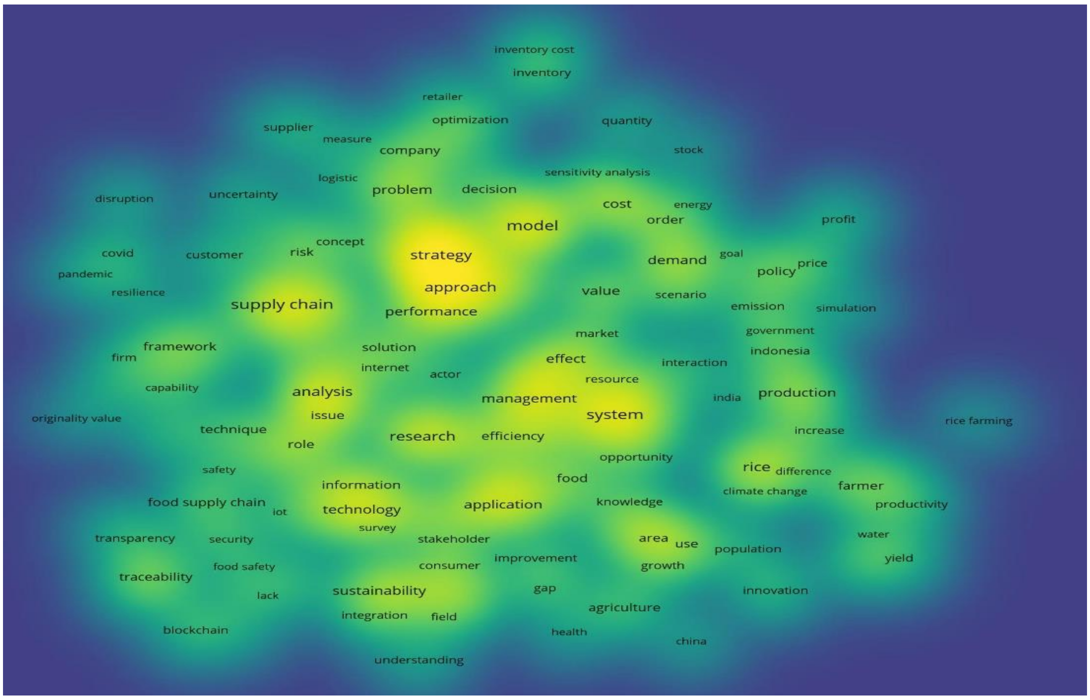

Figure 4. The density analysis of literature review

The achievement of sustainable productivity requires efficient inputs to minimize the impact of environmental damage. Integrated Crop Management is a sustainable rice production system practices with biology, environment and land management interaction (Erythrina *et al.*, 2021).

The production system at the rice mill generate 23% husk waste. This is a potential source of sustainable green energy biomass to replace fossil energy. Every ton of rice husk used as an energy source will reduce 474 kg of coal or 50 L of fuel (diesel and kerosene). This will cut CO_2 production by 105,339 kg CO_2 per ton of rice husk (Bantacut, 2017). There are distribution activities between the production and consumption sub-systems that involve transportation activities. The diversity of regional potentials creates surplus and deficit areas so that it is necessary distribution activities to meet the food needs more effective, efficient and minimize environmental impacts. The transportation produces carbon footprints from residue of the fuel combustion process. Carbon footprint efficiency is an indicator in green logistics that useful for minimizing the environment impact. Indonesia is committed to implement the green logistics in distribution activities (Umitri, 2023). Rice inventory control and supply chain performance are still major problems. The rice supply chain face insufficient supplies, uncertain inventory planning, and unpredictable demand (Bantacut and Fadhil, 2018). These uncertainties are risky for inefficient of production routes allocation which causes high carbon emissions from distribution activities. The green activities of rice supply chain is showed on Figure 5.

Integrated Method and Approach for Sustainable Rice Supply Chain

In order to realize the foundation of food security, namely food availability, accessibility, affordability, and sustainability (Timmer, 2017) requires the challenge of integrating supply chains from upstream to downstream. Integration will enhance benefits of effective and efficiency supply chains and logistics across the business process. Integration need collaboration and shared decision making with network partners (Büyüközkan and Göçer, 2018). The availability of rice supply needs to be identified from the production phase to calculate the production potential that can be generated from productivity enabler based on the development of agricultural technology innovations. The increasing productivity based on sustainability innovation will improve the value of rice supply chain. Production potential will be further validated if the development of innovation from the contribution of research and development is collaborated to increase productivity.

System dynamics is a method that can be used to predict production on complex system perspective. Jamaludin *et al.* (2021) used system dynamic to simulate rice yield increase by using the parameters of productivity and cropping index increase. The increase in productivity is assumed from changing varieties, organic fertilizers, pest and disease controlling, planting system, integrated farming systems and other components of cultivation. Artificial Neural Network (ANN) is an Artificial Intelligent Technique to perform predictive modeling by imitating the human brain which has connecting ability of data sets.

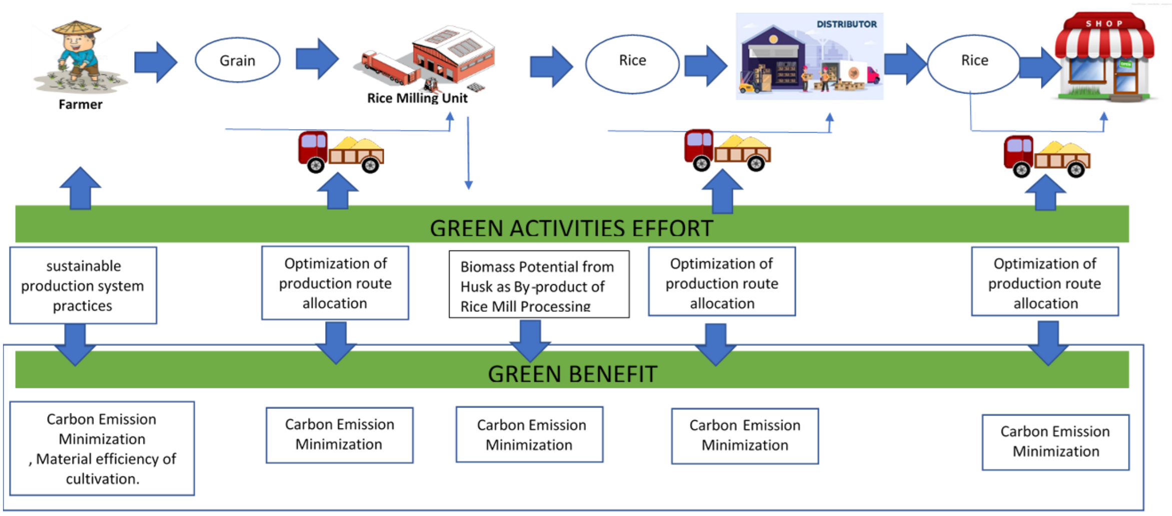

Figure 5. The Green Supply Chain Activities

Chu and Yu (2020) and other authors built rice production predictions modelling using ANN with specific parameters. Either single or hybrid prediction techniques used by researchers to estimate rice production. The potential of rice yield increase in the upstream, it will result in increased grain availability. The increasing volume of rice trade will transform performance in supply chain, namely changes in efficiency and responsiveness, as well as the need to design inventory optimization to manage distribution and safety stock in order to minimize costs and maximize distribution for consumption needs. Henceforth, the yield of potential production will be used as a variable to determine the level of inventory optimization. Douaioui *et al.* (2021) used a single mixed integer linear programming technique with the parameters of demand, production capacity and safety stock level using a fuzziness approach. Kao and Chueh (2022) developed a Supervisory Control And Data Acquisition (SCADA) system based on an IoT framework to collect sales data from downstream whose sales data is used to estimate production capacity to plan raw materials needs. When the amount of main ingredients in below the safety stock level, the manufacturer can actively notify the supplier and request replenishment. Gebennini *et al.* (2009) used the Mixed Integer Programming technique to determine the number of facilities (distribution centre, warehousing system), choice of location according to customer demand, safety stock, production level, and service level.

Azfar *et al.* (2014) divides performance measurement into 3, namely 1) Operational Performance (Inventory Level, Quality, Time, Customer Satisfaction); 2) Economic Performance (Cost, Environmental Cost, Cash to cash cycle) and 3) Environmental Performance (Business waste). Moazzam *et al.* (2018) used a SCOR-based BSC approach to measure performance in the New Zealand dairy industry. Authors try to integrate product quality and related risks in the performance measurement model with the parameters of reliability, responsiveness, assets, agility, and cost.

Traceability is a supply chain challenge to overcome food safety and food security issues. Designing traceability requires a systems approach because it involves interrelated elements in a complex environment. Jakkhupan *et al.* (2015) mention that traceability requires record requirements and data exchange from various sources. According to Ge *et al.* (2015), the critical point of traceability which difficult and takes time is the two-way integration of data in the agricultural supply chain structure through actors communication. Yakubu *et al.* (2022) noted that tracing requires much cost to trace transactions from producers to consumers. Therefore Yakubu *et al.* (2022) and Zhang *et al.* (2022) highlight traceability using a blockchain framework via smart contracts.

Traceability is a prerequisite for a sustainable agriculture food supply chain (Bastian and Zentes, 2013). Traceability engage the sustainability dimension in the supply chain. In the economic dimension, financial flow traceability is needed to monitor the movement of financial flows from one actor to another and to encourage fair trade that concern to price transparency according to quality and risk-based profits. In the social dimension, consumers need food safety traceability guarantees in the production chain process and product distribution. In addition, information on product movement will improve monitoring of product availability furthermore availability becomes more stable. In the environmental dimension, traceability is needed to determine the footprint of waste, emissions, and efficiency of resources used in supply chain activities. This is important to minimize the environmental impact in achieving green productivity.

Based on modern analysis of food security, the sustainability of the food system is an important component and challenge in the supply chain (Timmer, 2017; Yadav *et al*., 2022). Innovation with eco-friendly inputs such as nitrogen, phosphorus, and water efficiency, as well as appropriate of seed used (Wu *et al.*, 2015) will supports sustainable production. The profit indicator on the economic dimension is measured to find out how much the current production has an impact on the income earned by actors in the structure of the rice supply chain. If the increase in the volume of rice trade can be managed to improve inventory optimization, it will be beneficial for increasing efficiency and responsiveness in the performance of the rice supply chain. Transform food security towards sustainability by overcoming the challenges of supply chain integration will be able to increase the potential for sustainability value. Adaptive assessment techniques are needed to measure the dynamics of sustainability.

A number of authors used Sustainable Rice Platform (SRP) Standard for sustainable rice cultivation with different perspectives and techniques. Okpiaifo *et al.* (2020) weighted sustainability indicators in rice production using econometric techniques. Devkota *et al.* (2022) set sustainability targets from 12 SRP performance indicators using data sets from 7 countries by descriptive statistical techniques. A number of other authors used different standard indicators and techniques, including Goal Programming (Moreno García *et al*., 2021), P-value analysis (Sharma *et al*., 2018), SAFA (The Sustainability Assessment of Food and Agriculture systems) (FAO 2014), linkert scale weighting Ojo *et al* (2020), ANOVA (Arouna *et al*., 2021a; White *et al.*, 2020).

Research Gap

According to the literature review of research question, the integrated rice supply chain is less significantly carried out (Yadav *et al.*, 2022). Thus it is necessary to build system to integrate rice supply chain so that the solving problems in upstream will associate with planning formulation to address downstream emerging impacts. Therefore it is necessary to pay attention to supply chain development instruments from upstream to downstream such as information sharing and decision-making coordination as two major stages of supply chain integration at the operational level (Büyüközkan and Göçer, 2018). Focusing on a triple bottom line (TBL) perspective, sustainability should be seen as a holistic and interdisciplinary concept covering environmental, economic, and social issues at various stages in the supply chain (Garcia-Torres *et al.*, 2019).

Increasing productivity from the direct innovation aspect is mostly carried out in the scope of agronomy, and indirect innovation is mostly carried out in various areas such as engineering, environment, and smart farming model. The both aspects have contribution to increase productivity, but the result of simultaneously innovation adoption have not been found. In order to synergize the adoption and dissemination of innovation aspects, a causal loop in dynamic systems can identify the correlation between component that affects production. Dynamic systems have the advantage of modeling that it's able to sketch causal loops with several scenarios considered so the prediction will have various scenarios which can be used as strategies and future evaluation.

The institutional innovations are as important for sustainable growth and development as technological innovations (Singh, 2017). The case of institutional innovation on rice production inputs in India include bioinput production, machinery rental, and water. These inputs need collaboration with third party that incorporated of organizations or individuals. Institutional support to increase productivity based farming innovation could be acquired in partnership development with government and college research center. The researchers should have target to improve innovation product in order to contribute sustainable farming input. Other than the infrastructure as support facilities need to increased such as input supplier, including superior seed, efficient fertilizer, eco friendly pesticide and others therefore the farmers have easy access. In order to develop institution and infrastructure require studies about existing strength, weakness, opportunity and challenge to formulate the right strategy.

Inventory optimization models by considering safety stock are rarely for agricultural commodities, including rice. Safety stock supplies are widely used for industrial materials, oil and gas, and electronics. Rice products are found in institutions that have large warehousing facilities and play a role in managing food reserves. However, in order to realize food security and supply chain effectiveness, all relevant stakeholders need to plan optimal inventory levels by considering production absorption, safety stock, and effectiveness and efficiency of distribution to customers. The decision of inventory is a part of aggregate planning,that have causality with procurement, production, customer order, and shipment. The information technology is needed to operationalize the decision into material requirement, scheduling, supplier relationship and customer relationship. Therefore, Enterprise Resource Planning (ERP) is applicable to develop inventory optimization. According to Djatna (2020) ERP system architecture defines the relationship between complex information technology components, including: hardware, software, and data and complex organizational components such as enterprise structure, business rules, and people. The integration ERP and optimization technique to achieve efficiency, ERP and Iot to collect data and information, and ERP and blockchain to develop traceability will enhance the utilization of system. The study about these is needed for the future

The research related to supply chain performance measurement is rarely found for rice production, only in general, not specific commodities. It means the supply chain performance measurement model can be used for a variety of product supply chains that need to be measured. The gap is to prove the hypothesis that productivity increase and optimizing inventory levels can improve supply chain performance with the goals of responsiveness and efficiency achieving. Responsiveness is the speed at which a supply chain provides products to the customer in uncertainty demand and supply. Responsiveness is a customer-focused attribute. The responsiveness is conflicted to efficient. For every strategic choice to increase responsiveness, there are additional costs that lower efficiency. Therefore the efficient of supply chain focus on cost reduction (Chopra *et al.*, 2016)

The design of the traceability system of existing research was built to answer the issue of food quality (Purwandoko *et al.,* 2019b), food safety (Yakubu *et al.,* 2022), food fraud and information adulteration (Kumar and Iyengar, 2017), food fraud production methods, mislabeling, source or originality Yadav *et al.* (2022). There is still a missing regarding availability trace problem that might happen in scarcity situation causing information asymmetry and distortions among stakeholder. The sustainability goal also need to add in traceability system because traceability will engage the sustainability dimension in the supply chain.

Rice sustainability assessment research is widely found in Nigeria, Ghana, India, Peru, and the USA. The research has not provided results that predict sustainability based on the input logic that is used as the basis for reference. Most sustainability is assessed by weighting its performance indicators and is carried out in the cultivation area so it is necessary to include the dimension of sustainability in every business process so that the burden, benefits, and fulfillment of needs can be distributed to stakeholders in each rice supply chain.

The Future Research On Sustainable Supply Chain of Rice

Indonesia has an archipelagic geographic with diverse regional comparative advantages of natural resources, human resources so that it has different potentials that created central and noncentral areas on food availability and fulfilment, including rice. Central provinces that have high availability of rice or paddy stock can supply rice to other provinces where it is less available. However, it will be the ineffectiveness and inefficiency of the food supply chain. Moreover, if there is a climate change that decrease production yield, the dynamics of policies and pandemic situation which causes transportation restrictions, these situations affect the scarcity and inaccessibility of food. Furthermore, there will be impact on price increases. The price of rice during the Covid-19 pandemic was higher than highest retail price regulation. (Octania, 2021)

The supply chain is an integrated system with the view that the system is holistic to achieve a goal. The concern of the rice production supply to meet consumption demand need to be reviewed in the context of sustainability, which includes increasing production, balance, and stock availability, increasing efficiency and responsiveness, as well as the rights of stakeholders to access traceability information. The problem is a threat for the sustainability of food supply chain. Therefore, it is necessary to explore the potential of solution to improve the food system. The agricultural technology innovation is useful to increase the yield production in non-central areas through optimally utilizing dry land. The majority of 90% (26 million ha) of dry land and temporarily uncultivated land are located outside Java (BPS 2015). Most of the non-central areas are also located outside Java, including in the provinces of Papua, West Papua, Maluku, North Maluku, North Kalimantan, East Kalimantan, Riau, Jambi, Bengkulu, North Sulawesi and Gorontalo These provinces except Gorontalo also include in deficit rice area (BPS, 2022). Non-irrigated paddy fields including rainfed and swamps also have the potentiall to be developed to increase rice productivity. The introduction of new superior varieties on sub-optimal land is part of an effort to increase productivity through Integrated Crop Management (PTT) innovations (Suparwoto and Waluyo 2019; Beding and Tiro, 2020).

The development of innovations application of rice farming that aimed for rice yield increase should be calculated how much the increase from the adoption implemented by farmers. The contribution of innovation to increased production is measured from the variable area of land that improve rice variety, implement integrated crop management and others either direct or indirect innovations technology. The innovations that will be selected must require productivity criteria, minimize environmental impact, resource efficiency, food safety, and economic feasibility. Prediction of adoption innovation increase in some period will be a modeling scenario of increasing rice production in dynamic systems.

The results of potential products will be used as a variable to determine the level of inventory optimization for maximum absorption by rice actors, and also minimizes inventory buildup that impact on costs. Other variables used include production capacity, the need for food reserves, and market demand. The decision variables to be determined are inventory levels, production levels, backorder levels, and distribution levels. The investigation needed are identification of the distribution, transaction and safety stock of rice actors. Identification of the distribution of rice actors is needed to cluster these actors based on location, type of business, sales transactions, and facilities. Then the level of inventory optimization will be determined based on clusters for better suitability.

The distribution also considers area production potential. The distribution from surplus to deficit area should involve information technology and support infrastructure. It can adopt from number paper which discuss digital supply chain through blockchain, IoT and AI technology (Vilas-Boas *et al.* 2023). The distribution among areas require optimize transportation infrastructure, such as the right route based on road condition, storage facilities, and distribution center and technology infrastructure, such as sensor, internet, architecture and prototype. In order to connect distributor company among areas take information exchange to support some decision making, including the source of rice production, the date of shipment and transparent transaction. Blockchain technology is useful to minimize the risk of mistaken decision.

Rice requires an agile, reliable, and responsive supply chain to provide the right product, in the right quantity, the right quality, the right time and the right place, as well as the right cost. The production increase and optimizing inventory are hypothesis for supply chain performance improving. Therefore, it is necessary to measure the existing performance and the potential performance improvement using sustainability dimensional indicators.

Supply chain information traceability is developed by information systems. The information system will improve the performance of the material, information, and financial traceability by integrating data and information from various stakeholders (multi-user) which will minimize the risk of price fluctuations, food safety, and stock availability, as well as increase the effectiveness of the control and monitoring process. The design of the traceability prototype is carried out by identifying the transaction attributes that must be recorded by each stakeholder. Various approach including blockchain, RFID, Integrated information system is used to implement traceability practices. There is a decision made by stakeholder along traceability process, such as if it happen defect product, the stakeholder can decide the amount of product that must recalled, the location of product movement, and cost calculation to return the product (Qian *et al.* 2022). The decision support system based on data, model and front end is effective to make decision. The traceability model completed with database is collaboration concept that recommended for the future research. The decision support system is effective and efficient to make decision. Moreover the performance of traceability can be evaluated through Decision support system.

Outputs from increasing production aspects, level of stock availability, increasing efficiency, and responsiveness, as well as traceability information, will be considered to assess the value of sustainability that refers to economic feasibility, social support, and environmental preservation. The assessment of the sustainability of the rice supply chain uses economic, social, and environmental dimensions with standard rice sustainability indicators contained in the SRP (Sustainability Rice Platform), which will be complemented by supporting indicators from the previous output objectives consist of production, inventory optimization level, supply chain performance, and traceability performance.

CONCLUSION AND RECOMENDATION

Conclusion

Systematic Literature Review for the Sustainability Supply Chain of Rice is carried out to build and strengthen the literature framework systematically and critically to find links that have not been connected in the supply chain. The results reveal that 3 problem scopes are most found, namely complex supply chain, supply availability and sustainability awareness. Various research implementations addressed these problems, depending on interest scope. Nonetheless, it will impact less integration. Therefore, integrating it started from upstream needs for planning formulation to address downstream emerging impacts. The literature review and research gap analysis result focus on the sustainability integration of productivity, inventory, performance and traceability.

The potential of production increasing based on simulation of farming innovation yield requires inventory optimization to maximize production absorption but also minimize overstock risk. The production increasing and inventory optimization will transform the value of supply chain performance to be efficient, responsive and sustainable. Future Research will concern with rice supply and demand mismatch reviewed in a sustainability context, which includes increased production, stock balancing and availability, increased efficiency and responsiveness, as well as the need of stakeholders to access traceability information.

Recomendation

The future research of literature review is useful for researchers, agro-industrialist and government concerned with developing an integration system of rice supply chain. Researchers could explore the methods and approaches that have accurate and consistent validation as well as compatibility with the problem situation. Researchers should collaborate with agro-industrialist for data, information and experience sharing; therefore, the result could be implemented effectively. The government is essential in coordinating stakeholders to build an integrated system. Coordination will connect institutional linkage, which has complex interests but needs collaboration to achieve sustainability rice supply chain.

Future research will provide recommendations to agroindustrialists including farmers to produce rice sustainably from the development of agricultural innovation technology whose results will be predicted by researchers with appropriate approaches or methods. Inventory optimization will result decision recommendations to allocate absorption of production increase and minimize overstock risk. The potential of production increase and optimizing inventory is useful for assessing performance positions after the two activities above are carried out. It will provide recommendations for performance improving that is more efficient, responsive and sustainable. Traceability practices will increase efficiency so that the development of supply chain traceability in future research becomes an important indicator for assessing sustainability performance.

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