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A Literature Review on The Design of Intelligent Supply Chain for Natural Fibre Agroindustry

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***Abstract*— Natural fibre is an environmentally friendly raw material that has a great potential to develop, and is abundantly available in nature [1]. Currently, the growth of natural fibre processing industries in the world has been increasingly important [2]. Processing of abundant natural fibre in both upstream and downstream productions requires effective and collaborative supply chain management in terms of information sharing. Thus, an intelligent system would be implemented in supply chain management from upstream to downstream. Based on review of 46 scientific papers discussing on types of natural fibre, process, technology, and methods, as well as application areas of natural fibre in downstream industries. According to review on different aspects in 55 scientific papers, there were 5 aspects mapped, i.e. supply chain analytics, value chain, performance, collaboration, big data, and decision support system. A concept of 4.0 industry underlies utilization of opportunities for application of supply chain analytics [3]. Upcoming research opportunities include mediating relationship in supply chain network by utilizing Internet of things (IoT) and Big data (BD), in a collaborative relationship to use information sharing. The most possibly contributing research is the development of collaboration between supply chain and genetic algorithm [4]. Integration between production and inventory planning becomes an approach that utilizes Particle swarm optimization (PSO) by developing production planning [5], and production and inventory planning [6]. There is a research opportunity in the design of intelligent supply chain for natural fibre agroindustry by implementing IoT and BD as a tool in supply chain analytics, collaboration through Collaboration prediction forecasting and replenishment (CPFR) that occurs between stakeholders with the aim of improving agroindustry supply chain performance in production integration material and inventory, and performance measurement by integrating the Value chain operation reference (VCOR) model developed in supply chain analytics. The novelties of this research are supply chain intelligent model of natural fibre agroindustry, and digital platform of web-based natural fibre supply chain analytics (Web-based NFISCA).**

***Keywords*—** *natural fibre, supply chain analytics, collaboration, integration of production and inventory planning, performance*

1. Introduction

Agroindustry is an industry that produces goods whose main components are derived from animals or plants [7], and therefore natural fibre agroindustry is defined as an industry that produces goods whose main components are derived from plants. Currently, development of natural fibre processing industries around the globe is perceived to be more important [8][9]. This was said due to the fact that natural fibre as a renewable raw material is abundantly available in nature, showing a high toughness [1], potentially reducing weight of product that results in energy saving, reducing production costs, and increasing products' surface [10]. Moreover, people's awareness of environmental sustainability has grown globally.

An increased demand of natural fibre occurs along with rapid growth of world population [1]. An yearly average of world natural fibre production in 2016 was 8,763 tonnes [1]. The largest fibre production was from sugarcane waste which reported a number of 75 million tonnes [2], while the smallest was abaca which reported a number of 70 thousand tonnes [2]. Indonesia is recorded as a pineapple, bamboo [2], and cotton [11] producing country.

Natural fibre is non-toxic, showing a low density, easy to handle, abundantly available in rural areas, not abrasive, environmentally friendly, cheap, a good insulation against heat, renewable, having a

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specific, acceptable strength with a high toughness, as well as reducing skin and respiratory irritations [1] [12]. Some natural fibres such as kenaf have advantages of being able to grow well in degraded lands [1], being able to absorb toxic waste as much as 40%, being resistant to industrial wastes [13], being sold at a low price (dried state) [14], and not requiring a lot of water for its growth [1].

Nevertheless, some natural fibres still have disadvantages when compared to synthetic fibres. The disadvantages of natural fibres such as cotton include high usage of pesticide [15], only growing in fertile areas [1], being sold at a high price (dried state), and requiring a lot of water despite of raining [14]. It is different case with kenaf, whose fibre is difficult to handle when shipment as the length reaches 4 meters [1].

Sustainability of natural fibre as part of upstream industries which allows it to be raw materials for supporting and mainstay industries [16] have to be continually ensured through a supply chain management system. Collaboration, information sharing, coping up with congestion that leads to disruption in the supply chain can be performed with development of an intelligent supply chain. Intelligent supply chain is an open network that is more flexible. It connects information and application using an intelligent technology [17], which will ensure supply chain efficiency, quality control, cost advantage and customer satisfaction [18].

2. Natural fibre agroindustry

This literature review conveys researches on natural fibre that have been conducted. Table 1 presents a summary of literature review from 46 titles of scientific paper which covers types of fibre, process, technology, and methods, as well as application areas of natural fibre in downstream industries. Some downstream industries identified in this literature review who use natural fibre as their materials include composite, paper, food, pharmaceutical, biofuel, automotive, textile and its derivative (TD) industries.

Table 1 identifies 13 types of natural fibre, i.e. kenaf, flax, bamboo, pineapple leaf, abaca, cotton, sisal, jute, mendong, hemp, coir, ramie, and wood fibre. In order to map the distribution of scientific papers that become our research object in terms of supply chain, Figure 1 is provided.

Table 1. Summary of literature review on natural fibre and its application in downstream industries

Type of Fibre	Method	Industry (s)	Scientific Paper
Kenaf	Mechanical test, thermogravi-metric analysis	Fibre reinforced composite, hybrid composite	[19], [20], [21], [22], [23], [24], [25]
	Mechanical test	Paper	[26]
	Experiment	TD	[27]
Flax	Mechanical test	Composite	[28], [29]
Bamboo	Experiment	Food and pharmaceutical	[30]
Pineapple leaf	Experiment	TD, rope	[31], [32], [33], [34]
	Mechanical test	Composite	[35], [36]
	Mechanical test	Paper	[37]
Jute	Experiment	Packaging	[38]
	Experiment	Composite	[39], [40], [14]
Abaca	Mechanical test	Composite	[41], [42], [43]
Cotton	Experiment	TD	[44], [45], [46], [47]
	Experiment	Biofuel	[48]
Sisal	Experiment	Composite	[49], [50], [51], [52], [53]
Mendong	Experiment	Paper	[54]
	Tensile test	Composite	[55]
Hemp	Experiment	TD	[56]
Coir	Experiment	Automotive	[57]
Ramie	Experiment	Composite (soundproof)	[58]
	Experiment	TD	[59], [60]
Wood fibre	Experiment	Composite	[61]

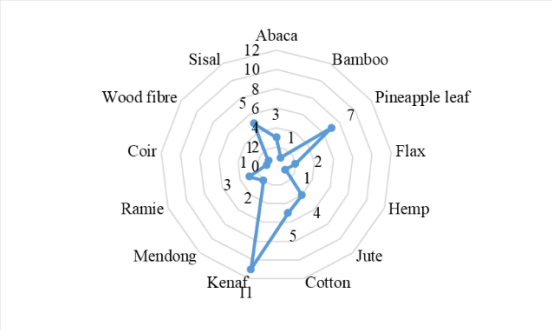

Figure 1. The distribution of scientific papers

3. Intelligent supply chain for development of natural fibre agroindustry

Supply chain consists of all activities associated with flow and transformation of goods from raw materials (extraction) to end consumers, and the related information. The flow of materials and information is very complex, and thus supply chain is defined as an integration of activities that involve information relationship through a better relation of supply chain, in order to achieve sustainable competitive excellence [62]. In supply chain, a complex process occurs, allowing congestion or disruption in different steps [63], and therefore information sharing between suppliers, partners, industries, retailers [64], transporters, warehouses, and even customers [65] [70] is necessary.

Supply chain is the series process sequence within a firm [66] of decision-making activities as well as a flow of materials, information, and money to meet needs of end customers that produces a service or product and that is related to the network, material, financial, and information flows across suppliers and customers [65]. Table 2 elaborates a literature review summary of 6 scientific paper's titles which discuss about it.

Table 2. Definitions of intelligent supply chain

Paper	Definition
[17]	Intelligent supply chain is an open network system that is more flexible. This system will supply a network from each member of groups and companies using intelligent technology and coordination of supply chain management, in order to reach goals of being transparent and intelligent.
[67]	• Intelligent supply chain management system is an approach which combines advantages of IoT and cloud to distribute right products to the right destinations at the right time using the right transportation, in order to achieve an efficiency. • This system will provide a real-time monitoring. The system aims to create an interactive supply chain ecosystem, including location of product, location of packing process, types of packaging, and vehicle responsible for transportation which also tells product location, product quality status, and route selected to the users. • Everything should be in an intelligent system, and this intelligent system will ensure that supply chain management works efficiently, with aims to improve quality control, cost efficiency, and customer satisfaction.
[68]	In its management, an intelligent supply chain employs a system developed by artificial intelligent studies, expert system, genetic algorithm (GA), artificial neural network, knowledge-based system, and fuzzy logic.
[69]	• Intelligent supply chain is a supply chain network equipped with collaborative management and monitoring of different companies involved the supply chain. The system captures information required and establishes procedures and accountability, criteria of performance measurement, as well as ability to solve extraordinary cases. • Implementation of intelligent supply chain will provide flexibility and control of an effective business model to companies, and produces mechanism to analyze and comprehend impacts of a collaborative business process on its operation.
[70]	Intelligent supply chain is an integration of intelligent supply chain with a Cloud of things (CoT) concept-based management system.
[71]	Intelligent supply chain has to own these characteristics: (1) real visibility of internal demands, (2) possible, global visibility of website, (3) computerized, technical architecture, (4) real-time planning, (5) report and analysis.

Thus, an intelligent supply chain is a network of companies (supplier-manufacturer-distributor-retailer) that is flexible and integrated in a collaboration and connected in computer devices with employment of IoT, whose management uses an approach of expert system, GA, artificial neural network, knowledge-based system, and fuzzy logic, so that supply chain management is ensured working efficiently through quality control, cost efficiency, and customer satisfaction.

4. Method

Scientific papers studied in this literature review adopted frameworks developed by [68]. Literature review presented in Figure 2 establishes online database to discover the scientific papers, criteria of the literature review, classification in the criteria of literature review, and classification of approaches and methods used in the selected scientific papers. The flow diagram ends with establishment of this study position.

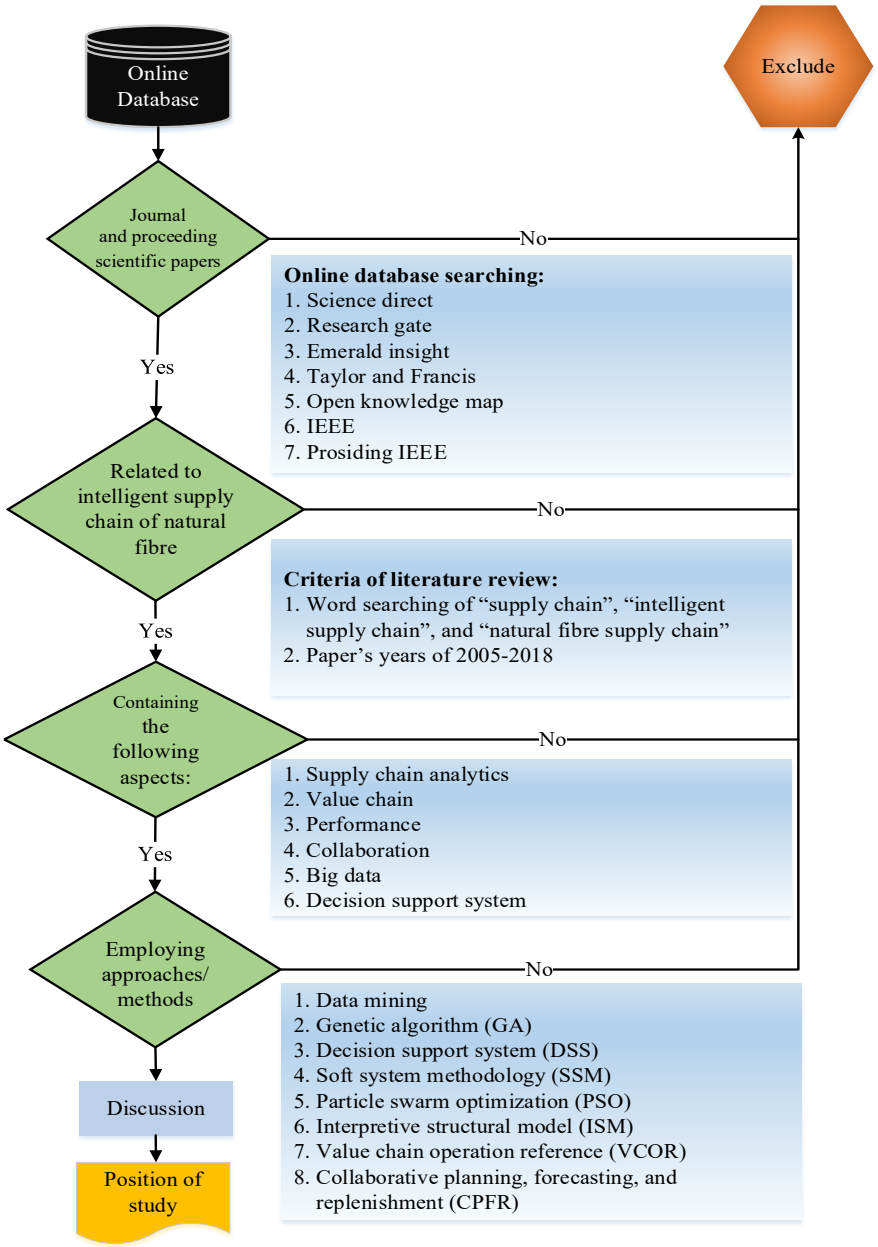

Figure 2. Flowchart of intelligent supply chain literature review for development of natural fibre agroindustry

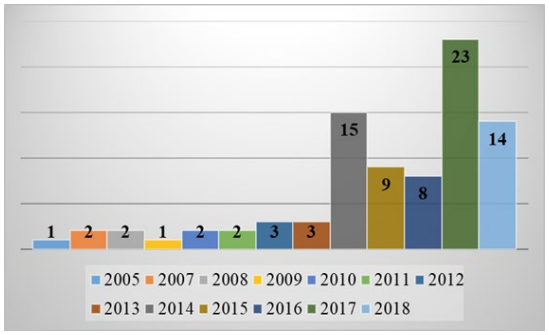

Figure 3. Distribution of the scientific papers

Literature review in the first stage of this study was performed by collecting scientific papers from scientific journals and proceedings contained in online database: (1) Science direct, (2) Research gate, (3) Emerald insight, (4) Taylor and Francis, (5) Open knowledge map, (6) The Institute of Electrical and Electronic Engineers (IEEE), and proceedings published by IEEE. Keywords reviewed from the scientific papers are: (1) Supply chain, (2) Intelligent supply chain, and (3) Intelligent supply chain of natural fibre. Figure 4 presents distribution of paper's publication years. There were 6 titles of proceedings and 48 titles of scientific journals discovered. The year 2017 produces the most library searches, which is 23 titles.

5. Results and Discussion

5.1. The mapping of intelligent supply chain of natural fibre agroindustry

Intelligent supply chain mapping was performed to the 86 titles of scientific papers. There were 31 titles relating to contents of supply chain, 55 titles relating to contents of intelligent supply chain, while none found relating to natural fibre intelligent supply chain. Therefore, this study potentially fills the gap of researches in the area of natural fibre intelligent supply chain. This gap is as presented in Figure 4.

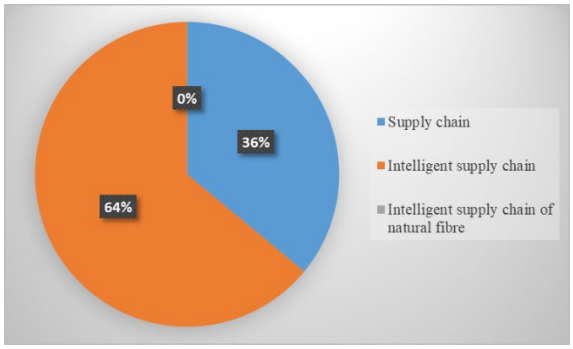

Figure 4. Mapping of scientific papers

Over 55 titles of scientific papers which relate to the content of intelligent supply chain, there were 18 titles whose research's objects were unspecified manufacturing industries. This is as found in a scientific paper of [72] which conducted research on collaboration in supply chain to improve competitive excellence of industries through an approach of fuzzy expert system in manufacturing industries whose products were not specified. In addition, [73] also conducted research to predict positive impacts of supply chain analysis and its ability to improve performance of supply chain management using an approach of GA and fuzzy logic, without specifically mentioning products manufactured by the industries.

There were 7 titles of scientific papers that used retail industries as their research objects. Scientific paper of [64] used retailers as its research object when comparing some influential factors in adoption of a CPFR approach in retailers. Scientific papers of [74] and [75] examined analyticsal ability the other hand, scientific paper of [6] conducted research on optimization action of retailer's dynamic performance in terms of production and stock control systems in order to minimize gap ratios between order levels and consumption using a PSO approach. Other three researches that set retails as their research objects are [76] who used an approach of Decision support system (DSS), and [77] which studied retails in India using an approach of business intelligent.

Four automotive industries that become our objects in terms of intelligent supply chain are [78] who applies CPFR with an approach of Fuzzy extended analyticsal hierarchy process (FEAHP) in order to improve operational performance of supply chain, [79] who applies CPFR with assistance of DSS in multi-agents system in order to improve profits and customer service level, and [80] who applies Supply chain operation reference (SCOR) to measure supply chain performance.

TD industries were found in 3 titles of scientific paper which relate to intelligent supply chain. Scientific papers of [69] implemented business intelligent system to improve collaboration, [68] conducted a literature review on contents of intelligent supply chain with GA approach, fuzzy logic, imitative nervous system, and [81] implemented collaboration model through data sharing in apparel industries.

One scientific paper title in the intelligent supply chain content used composite material industries [82] as its research object with a theoretical approach of fuzzy set to establish the technology. This is due to the fact that composite raw materials are not derived from natural fibre, but from carbon fibre.

Based on a review of these 55 scientific papers, it is confirmed that there is still a huge gap to fill with a research theme of natural fibre-based intelligent supply chain. Therefore, this study set its theme on intelligent supply chain of natural fibre agroindustry.

The next stage is identifying aspects of 55 scientific paper's titles containing intelligent supply chain. There were 5 aspects in the discussion of intelligent supply chain, i.e. supply chain analytics, value chain, performance, collaboration, big data, and decision support system. Results of literature review on these five aspects in several journals studied are given in Table 3.

Table 3. Articles distribution based on title

Aspect of Research Position	Title of Journal	Scientific Paper
Supply chain analytics	International journal of logistics research and applications	[83]
	Computers and industrial engineering	[84]
	International journal logistics management	[74]
	International journal information system supply chain management	[71]
	Information management computer security	[85]
	Computer operation research	[86]
Supply chain analytics	International journal production economy	[87]
	International journal information technology decision making	[73]
	Science world journal	[88]

Aspect of Research Position	Title of Journal	Scientific Paper
	International journal production research	[89]
	The second international Conference on computing, communication and networking technologies	[90]
	International journal supply chain management	[91]
	Business horizons journal	[80]
Value chain	Production planning control	[3]
	International journal production economy	[92]
	International journal value chain management	[93]
Perform-ance	Business process management journal	[94]
	Expert systems with applications	[68]
	Omega	[95], [96]
	Production operation management	[97]
	Industrial management and data systems	[98], [99], [100]
	Production & Manufacturing Research	[101]
Collabo-ration	Lectures notes business information process	[64]
	Intelligent automation and soft computing	[78]
	International journal logistics management	[102]
	International journal of u- and e- service, science and technology	[69]
	International journal of systems science: operations & logistics	[72]
	International journal of production research	[103]
Big data	International journal of logistics research and applications	[83]
	Computers and industrial engineering	[84]
	International journal logistics management	[74], [104]
	International journal of u- and e- service, science and technology	[69]
	International journal information system supply chain management	[71]
	Computer operation research	[86]
	International journal production economy	[87]
	Procedia - Social and behavioral sciences	[105]
	International journal information technology decision making	[73]
	Science world journal	[88]
	Journal model management	[106]
	The second international Conference on computing, communication and networking technologies	[90]
	Business horizons journal	[80]
Decision support system	Computers and industrial engineering	[6]
	Expert system application	[107]
	Journal model management	[106]
	Procedia computer science	[108], [109]
	Cogent engineering	[110]
	International journal logistics management	[111]

According to the searching on intelligent supply chain-related aspects in Table 3, methods and approaches to employ are mapped. There are several ways to map methods in a literature review. One of the mapping is done by making groups formed. As [112] did, mapping was done based on quantitative, semi-quantitative and qualitative methods. This literature does mapping based on intelligent system methods, optimization, decision support systems, collaboration, and performance. The results are given in Table 4.

Table 4. Mapping of methods and approaches in research of intelligent supply chain design for natural fibre agroindustry

Mapped of methods	Method/ Model/ Technique	Scientific Paper
Intelligent system	Fuzzy logic	[72], [101], [113], [68]
	Expert system	[68]
	PSO	[6], [5]
	Business intelligent	[114], [84], [69], [71], [85], [77], [113], [3]
	GA	[84], [74], [68], [98], [96], [113], [90], [91]
Optimization	Multi objective optimization	[6], [100], [115]
Decision support system	Decision support system	[114], [92], [68], [6], [107], [108], [109], [110]
Collabo-ration	CPFR	[114], [116], [78], [117], [69], [72], [81], [103], [118], [119], [111], [120]
Performance	SCOR	[83], [97], [96], [80], [121], [3], [88]
	VCOR	[97], [122]
Other methods	Big data	[83], [84], [117], [123], [71], [87], [105], [104], [73], [90], [80]
	IoT	[83], [117], [96]
	ISM	[78]

Methods or approaches in line with the 5 research reviews would be used to answer questions regarding intelligent supply chain design of natural fibre agroindustry. Methods used include VCOR, DSS, CPFR, ISM, business intelligent system, GA, PSO, BD, and IoT.

In addition to tracing the supply chain analyticsal aspects, aspects of collaboration are also explored to establish research gaps that will be filled in this

study. There are 17 methods used in the collaboration aspect in 14 intelligent supply chain scientific article titles. The CPFR method is the most common method. In the article [79] comparing the influential factors when adopting the CPFR approach carried out by retailers and suppliers. Article [78] sets priority on CPFR by employing ISM and Fuzzy AHP. Article [69] identified supply chain collaboration by using the intelligent business approach, while article [72] used an expert systems approach, and article [119] used an optimization approach. In the article [117] attempted to determine supply chain performance by measuring CPFR.

There were 9 titles of scientific papers employing SCOR and VCOR approaches in the group of performance method. Seven (78%) titles of scientific papers employed an SCOR approach, while it was only 2 (22%) titles of scientific papers employing a VCOR method in order to compare with SCOR [97], and to improve performance based on decision making [122].

To criticize nine scientific papers employing SCOR and VCOR, Table 5 presents objects, methods, advantages, and limitations found in these scientific papers.

Table 5. Advantages and limitations of the supply chain performance method

Paper	Object/Method/Finding/Limitation
[80]	**Object:** Automotive industries in Iran
	Method: SCOR, business analytics, structural equation modelling, partial least square
	Findings: • Developing a comprehensive model to examine impacts of business analytics on supply chain performance • There was positive correlation between business analytics and supply chain performance • Combining resource-based theory and resource-dependence theory in order to develop framework to show the importance of business analytics in improving supply chain performance
	Limitations: There was not descriptive, predictive, and prescriptive explanation in the employment of business analytics to improve supply chain performance
[83]	**Object:** Survey of PMA's employees in America, Middle East, Europe, Asia, and Australia
	Method: Big data survey using structural equation modelling
	Findings: • Revealing new description of SCOR model through combination between big data and supply chain management (SCM) • Performance measured: management of demands, rating of vendors, IoT, analytics, science data • Implementing big data to measure SCOR-based performance through plan, source, make, deliver, and return.
	Limitations: Implementation technology of big data requires in-depth knowledge and costs in initial stages, enabling it to inhibit adoption of big data in supply chain industries
[88]	**Object:** Manufacturing industries
	Methods: Data mining, predictive analytics, SCOR
	Findings: • Developing web-based portal to monitor predictive supply chain performance based on predictive analytics • Combination between online analyticsal processing (OLAP) approach, key performance indicator (KPI), and data mining of predictive analytics which are integrated in a portal web to improve supply chain performance • Integrating predictive analytics with SCOR • Detailly depicting predictive performance model of supply chain
	Limitations: Performance measurement shows different results when analytics activities start with descriptive analytics that have not performed in this study
[3]	**Object:** Manufacturing industries
	Method: SCOR
	Findings: • Developing descriptive, predictive, and prescriptive analyses which are integrated on the SCOR model for a source-make-deliver-return supply chain network • Demonstrating samples of decision making in source-make-deliver-return which are strategic, tactical, and operational; as well as describing them in details
	Limitations: This research has not discussed costs and revenue, so that revenue of companies are known through management of company's revenue which implements an SCOR model with supply chain analytics
[96]	**Object:** Manufacturing industries whose commodities are not specified
	Method: SCOR, decision support system, multi objective optimization, technique for order preference by similarity to ideal solution (TOPSIS), GA, metaheuristics algorithm, non-dominated sorting GA II (NSGA II), IoT
	Findings: • Developing IoT based on performance management framework of supply chain • Developing IoT based on real-time framework to sustainably improve supply chain performance • Developing in-details mathematics optimization model, starting from identifying variables of decision and obstacle up to approaches to solve problems • Literature review in relation to performance was presented in details
	Limitation: Computation step of problem solving was not reported in details
[97]	**Object:** Packed-pineapple industries in Europe
	Method: SCOR, VCOR, ARENA simulation
	Findings: • Revealing comparison between SCOR and VCOR from customer's point of view • Developing a VCOR concept using plan-govern-execute • VCOR concept was explained in nearly details • Developing indicators of SCOR performance with addition of innovations and customers
	Limitations:

Paper	Object/Method/Finding/Limitation
	• It requires large amount of funding and large organization to implement results of simulation • Recognized limitations can be overcome by improving quality of services, market expansion, competitiveness, flexibility, fast response, innovation, and other features which are essential for companies to survive in the global market • Having not detailly providing information of each indicator at each level to existing matrices • Having not been able to depict real world conditions
[102]	**Object:** Unspecified industries
	Method: SCOR, CPFR
	Findings: • Developing framework for supply chain collaboration, which includes collaboration performance system, information sharing, decision adjustment, incentive equality, and integration of supply chain process • Developing a simple structure of supply chain collaboration
	Limitations: • There were no performance indicators • Performance measurement have not appeared in a CPFR generic model
[121]	**Object:** Electronic commerce
	Method: Business analytics, SCOR, promatics
	Findings: • Developing an SCOR model with a direct (automatic) data extraction and a company system which are integrated as a supporter in business intelligent of supply chain • Developing an integrated i-SCOR architecture (SCOR, i-SCOR knowledge based, e-Business suites requirements, and e-Business suites) • Detailly describing supply chain's KPI into an SCOR diagram
	Limitations: These companies have owned a Business suites system that may be not compatible with an automatic integration of the SCOR model
[124]	**Object:** Manufacturing industries
	Method: VCOR
	Findings: • Developing three models of value chain optimization, i.e. (1) mapping company's strategies using a relationship map, (2) analyzing value chain based on best practices in a management operation discipline, and (3) analyzing business process of value chain • Developing Zachman framework by identifying data, function, network, human, time, and motivation
	Limitations: This study would be easier to comprehend when examples of VCOR implementation in industries were given

Description given in Table 6 demonstrated advantages and limitations of employing the SCOR method as compared to VCOR. SCOR method has been widely used in measurement of supply chain performance, while there are not many researcher developing or employing VCOR in measurement of supply chain performance. Accordingly, implementation of VCOR model to measure supply chain performance of natural fibre agroindustry can be a future research opportunity.

5.2.Recommendation (Future Research)

For a research recommendation, some future opportunities to develop and enrich coverage of the existing discussion are delivered, as presented in Table 6.

Table 6. Research recommendation

Paper	Recommendation (Future Research)
[69]	• This study developed factors for critical success of textile industries in Korea, ranging from environment, governance, information technology support, up to collaborative relationship. One of factors which is very likely to develop in next studies is the factor of supply chain performance, of which application is seen in non-textile industries. • Upcoming studies may explain implementation of 9 stages of CPFR process in non-textile industries.
[73]	Giving evidence that five hypotheses mentioned in this article is able to be implemented in supply chain industries. Hypothesis 1: The higher the level of Data management capabilities is, the higher the supply chain performance in industries is. Hypothesis 2: The higher the analyticsal level of supply chain's process capabilities is, the higher its performance in industry is. Hypothesis 3: The higher the management analytics level of supply chain performance is, the higher its supply chain performance in industry is. Hypothesis 4: The higher the analytics level of supply chain, the higher its supply chain performance in industry is. Hypothesis 5: The higher the disturbance in industrial environment is, the higher the contribution of supply chain analytics to supply chain performance in industry is.
[72]	• There were only 3 levels of fuzzy expert system (FES) used in this research, i.e. Low, Medium, and High. Thus, it can be developed into 5 to 7 levels in next studies. • In this research, the importance at every level was assumed to be equal, and therefore next studies may develop varied importance at each level of fuzzy rules
[64]	• Cultures and characteristics of companies are different in different countries, so that results of the study cannot be implemented immediately before being adjusted to those differences. This can be an opportunity to study in the future. • ANP model may attempt to establish weights in each factor affecting on CPFR in next studies • Factors affecting on CPFR may be added in next studies, and compare them with retailers and suppliers
[6]	• Studies emphasize on one stage of supply chain with matched conditions between actual and predicted periods. • A research opportunity that may be filled is solving a stock problem when there is a gap between actual and predicted periods, so that the supply chain performance can be improved
[84]	• A research opportunity identified is implementation of big data analytics (BDA) in specific industries • SCM implementation has to be studied based on real-time data, particularly BDA for procurement strategy, network design,

Paper	Recommendation (Future Research)
	procurement management, and supply chain-supporting factors such as coordination, flexibility, and sustainability
[86]	• There is an opportunity to study order selection problems by implementing big data as an enabler in a warehouse system and optimization processes, i.e. order batching, routing, and sourcing • There is an opportunity to study models and decision makings that give inputs for preventive-detection proactive acts of procurement risks based on a large amount of database supplier • Prescriptive studies are still rarely conducted, and therefore there is an opportunity to contribute in this level of research • Excellence of logistic/transportation classification and procurement have not widely explored • It will be a great advantage to implement BDA for detecting fraud and safety-based behaviour analysis
[88]	Research opportunities include examining incorporation of OLAP, KPI, and data mining of prescriptive analytics, which are integrated in web portal to improve supply chain performance
[3]	• There are opportunities to conduct studies on price analytics which correlate with income management in industries that manufacture perishable products in a constant capacity • There are opportunities to detect local trends of social network to adjust inventory and prices. This is an attempt to equate supply and demand through increasing competition • Through big data, demand-forecasting method is developed, disturbance in supply chain is detected, and global communication between supply chains is improved
[97]	• Future research opportunities include complementing implementation of VCOR model's templates by adding flexibility aspects and re-employing simulation approaches that have been performed • Upcoming studies may employ an expert system approach, fuzzy logic, and decision support system to develop ARENA simulation used in this study
[102]	To extend the understanding of supply chain dynamics, it is necessary to perform pairwise interaction test on 5 variables present in collaborative framework of supply chain (collaborative performance system, decision synchronization, integration of supply chain process, incentive equity, and information sharing) in order to create changes towards a better overall performance
[103]	• Research opportunities found in this study include considering an aspect of disturbance that often occurs in each level of supply chain, an aspect of extremely varied cost, and profit parameters • Current stock models that use discrete random variables can be developed into functions of probability density
[5]	In order to improve problem solving performance in the future, modified PSO can be applied to overcome aggregated problems that are more complex, and compare them with more algorithms, such as imitative nervous system, ant colony optimization, agent-based model, and fuzzy logic
[116]	• Next possible studies in an aspect of supplier development include (1) Understanding roles of short-term profit as compared to long-term profit for suppliers when investment from different countries are made (current investment is from China), and (2) Understanding social roles and responsibility in different industries and countries • This research was based on knowledge management of supply chain using secondary data, and the research opportunity is development of evidence-based systems • Upcoming studies include consideration of downstream industries in supply chain to develop managerial ability of green supply chain
[117]	• This research employed an interview method of questions mentioned in questionnaires to gain data that would be analysed using statistics approaches. The results are perceived to be bias, as the respondent was a top manager who was expected to answer the overall supply chain process. • It is essential to pay attention to variables related to measures, ownership structures, and manufacturing industries when performing model examination in next researches, also it is recommended to conduct the study in similar industries • Future studies may include more variables, such as corporate's capacity in absorbing new values and information that potentially develops the industries (absorptive capacity), competition of supply chain, and uncertainty of environment
[119]	Next studies may be based on employment of an CPFR optimization model which can be conducted by examining accuracy of service level, reducing stock, and competitive excellence after the stage of implementation.
[4]	• Advanced studies may employ GA dynamics to develop collaborative network of supply chain • Next studies may employ other methods of network analysis, such as balance, betweenness, blocks, cliques, closeness, and density, in order to further analyse network structure of GA of supply chain network

To confirm establishment of novelty in this study, Figure 5 presents research establishment mapping of an intelligent supply chain model design for development of natural fibre agroindustry, based on 17 titles of main scientific papers. This mapping is focussed on research positions that will be developed, i.e. supply chain analytics, supply chain collaboration, integration between production planning and stock, as well as supply chain performance of kenaf-based natural fibre agroindustry.

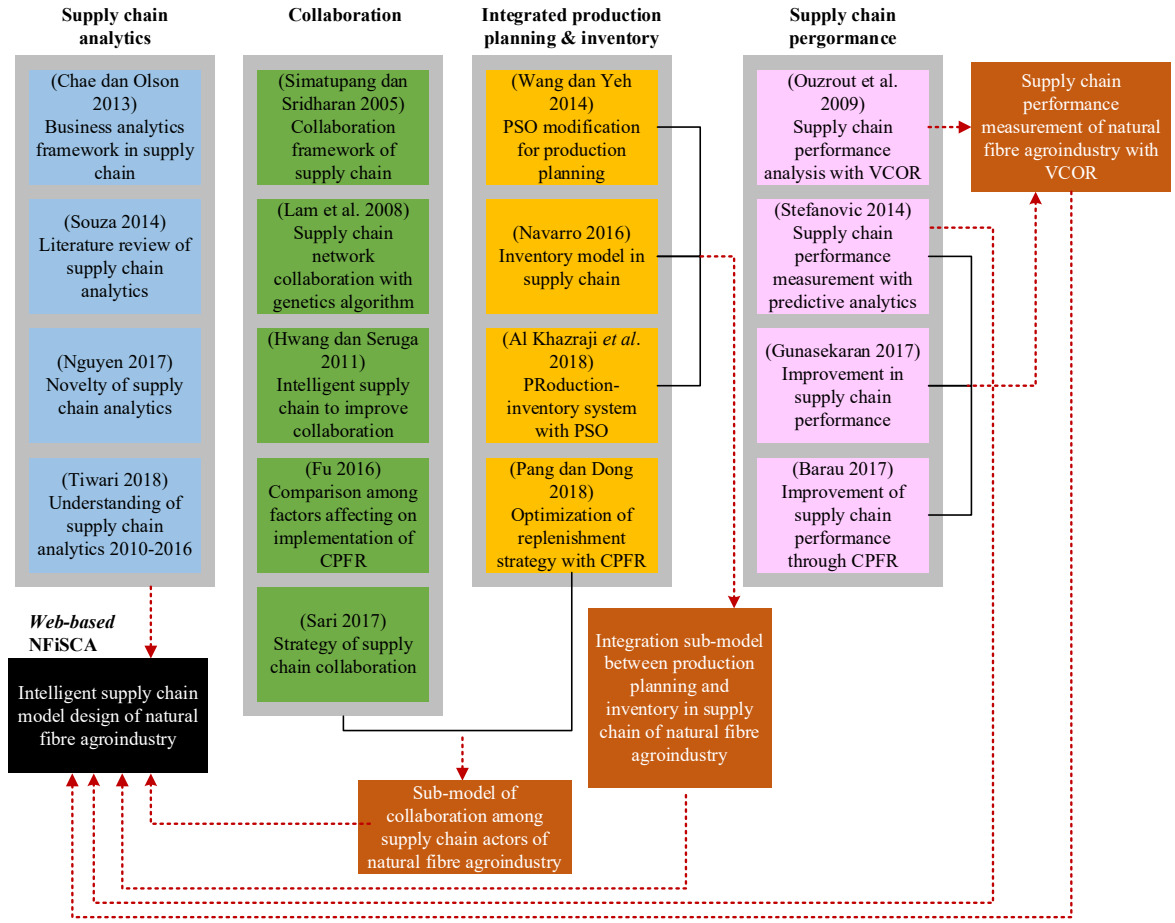

Figure 5. Research novelty establishment mapping of intelligent supply chain model design for development of natural fibre agroindustry

6. Conclusion

Research ideas that contribute to the area of agro-industrial technology in designing an intelligent supply chain model for development of natural fibre agroindustry include:

(1) The concept of 4.0 industry underlies implementation of supply chain analytics [3] in an intelligent supply chain model design of natural fibre agroindustry development. Contribution of supply chain analytics initiates with real-time descriptive analysis (data mining), such as explanation of research opportunities that has been performed [84], by applying plant sensors in order to gain information of production targets (crops) of kenaf until it is ready to process and distribute to medium-level industries. The next analytics is predictive, which gives opportunities as claimed by [125] by confirming that there is still a few studies completing analytics works in the prescriptive analytics area. Therefore, the stage of supply chain analytics terminates in the level of prescriptive analytics, through an approach of GA optimization. In addition, a contribution opportunity from this study is an urge to develop an answer of a hypothesis constructed by [73], which is the higher the level of process capabilities supply chain analytics is, the higher the performance is.

(2) This study potentially contributes to mediation of relationship among suppliers, buyers, distributors, processors, retailers, and exporter in utilizing IoT and big data concepts, in a collaborative relationship in order to harness information sharing. The most possible contributing research to conduct in the future is development of supply chain collaboration using a GA approach [4]. In the scientific paper of [69], an opportunity to contribute to implementation of 9 stages of CFR in natural fibre agroindustry supply chain was indicated. In addition, a scientific paper-based research opportunity proposed is examination of paired interaction among 5 variables present in a supply chain collaborative framework (collaborative performance system, decision synchronization, integration of supply chain

(3) process, incentive equity, and information sharing). Next, variables in collaboration may be added in order to improve natural fibre

agroindustry supply chain, according to research opportunities claimed by [117].

(4) Integration between production planning and stock becomes one of approaches in realizing an intelligent supply chain, and therefore this research opportunity will utilize an PSO approach by elaborating a study that has been conducted by [5] in production planning, and by [6] in production planning-stock. Furthermore, upcoming research opportunity to contribute to integration between production planning and stock is utilization of collaboration that will be mediated through an CPFR optimization model by examining accuracy of improvement in service level, stock reduction, and competitive excellence after implementation [119].

(5) The research potentially contributes to supply chain performance measurement of natural fibreprocess, incentive equity, and information sharing). Next, variables in collaboration may be added in order to improve natural fibre agroindustry supply chain, according to research opportunities claimed by [117].

(6) Integration between production planning and stock becomes one of approaches in realizing an intelligent supply chain, and therefore this research opportunity will utilize an PSO approach by elaborating a study that has been conducted by [5] in production planning, and by [6] in production planning-stock. Furthermore, upcoming research opportunity to contribute to integration between production planning and stock is utilization of collaboration that will be mediated through an CPFR optimization model by examining accuracy of improvement in service level, stock reduction, and competitive excellence after implementation [119].

The research potentially contributes to supply chain performance measurement of natural fibre agroindustry by integrating a VCOR model that has been developed [97] into supply chain analytics in a prescriptive analytics step [88]. The integration process which aims to improve supply chain performance will utilize IoT which performs real-time data mining, then extract the data into useful information through development of web-based application.

The novelties of this research are supply chain intelligent model of natural fibre agroindustry, and digital platform of web-based natural fibre supply chain analytics (Web-based NFISCA).

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