Methods and Approaches of Decision Support System for Coconut Agroindustry Development and Down-streaming: A Systematic Literature Review and Future Agenda

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***Abstract*— Decision support system in development and down-streaming of coconut-based agroindustry constitutes a meaningful approach for stakeholders in decision making process, in which it is semi-structural process in coconut agroindustry. This current work aimed to identify and analyse a method and approach in development of coconut agroindustry and its downstream, as well as to collaborate and criticize both stages. This work has reviewed 110 scientific articles from 5 main publication databases worldwide published between 2010 – 2019. The results showed that methods or approaches for agroindustry development and downstream agroindustry in general and especially in coconut agroindustry, discussed a lot about traditional development and downstream coconut agroindustry by 97%. On the contrary, studies pertaining the use of intelligent spatial decision support systems that can accelerate decision making and research on upstream and downstream integration in coconut agroindustry were still low at 3%. Based on these research gaps, a research framework is produced, enabling to construct the intelligent decision support system for the development and downstream of coconut-based agroindustry by integrating aspects of potential area mapping models, product development, and institutions.**

***Keywords*—** *agroindustry development, coconut, decision support system, downstream agroindustry, method and approach*

1. Introduction

Decision making system approach is useful in making a decision for stakeholders dealing with current problems under uncertainty of decision making [1]. Multi-criteria decision making is commonly used for tackling problems based on some present criteria, consisting of Multi-Objectives Decision Making (MODM) and Multi-Attributes Decision Making (MADM)[2]. In order to raise effectivity, decision making support system needs to involve the use of computer-based information system which is interactive, flexible, and easy-to-adapt, specifically developed to tackle unstructured management problems, as commonly found in agroindustry sector [3].

Development and down-streaming of agroindustry sector strictly relate to value chains comprising of raw material, processing and market [4]. Selecting high quality raw materials greatly contributes to the industry; thus, location is essential in order to ensure the supply of raw materials [5]. Processing is also significant with respect to further product development capable of meeting consumer's need, which is key to product successfulness [6]. This requires actual efforts to trigger investment, increase added value, and seek new markets in both domestic and abroad. The commitment of increasing the growth in agricultural sector is a must, when we strongly want to present people-oriented agriculture that is modern designed and highly responsive to global changes [7]. In this case, coconut industry has been believed to bring high impact to economy [8]. The coconut plant is a tropical crop, well grows in lowlands and even middle lands in coastal area,

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irrigated or not irrigated, mostly spread in lowland tropical areas of Asia. In last 500 years, coconut trees have been continuously cultivated in lowland tropical area in Africa and Neotropics, in which soil condition and climate is acceptable for their growth [9].

Complexity of coconut agroindustry problems is due to the involvement of many stakeholders; thus, a model is needed to assist decision making process [10]. Therefore, to enrich analysis and development of method, we perform decision making approach with regard to development and down-streaming of coconut agroindustry. Our present work aimed to identify and analyse the approach used in development and down-streaming of coconut agroindustry, then collaborating the development and down-streaming of coconut agroindustry, as well as criticizing the approach developed.

The research is expected to produce system framework related to development and down-streaming of coconut agroindustry. In this work, we have mapped current methods and approaches mainly discussing about coconut agroindustry. Mapping process was performed systematically, from identification to classification of the methods and approaches. The literatures discussing development and down-streaming are wide, complex and uneasy to understand; thus, method and approach mapping is made to assist research community, primarily related to coconut agroindustry.

2. Literature Review

Coconut (*Cocos nucifera* L.) is perennial versatile plant and important crop in tropical areas. It grows in more than 80 countries, offering a substantial role for diverse life in coastal and islands ecosystem. The main coconut producers include Indonesia, Philippine, India, and Sri Lanka [11]. Coconut (*Cocos nucifera* L.) is the only living species of the genus Cocos, a member of Ericaceae, tribe Cocoa, with the chromosome number of 2n = 32 [12]. Globally, it is classified into tall coconut (typica) and dwarf coconut (nana), which differs in terms of physical appearances and genetics. Morphologically, coconut tree is commonly tall, producing roots from the base of stem, bearing a big crown and nut [13]. Although coconut is widely cultivated by small scale farming in some countries, such as Malaysia, it now becomes integral part of economy growth. Generally, integrated farming system of coconut covers other crops including corn, banana, cocoa, peas, fruits (papaya, pineapple), coffee, and tubers. The integrated agriculture is needed to raise income.

Agroindustry significantly contributes to conversion of various animal and plant sources into products through some processes including transformation, preservation, storage, and packing, and distribution. Degree of material processing and its transformation may vary, starting from cleaning, sorting, milling, cutting, canning, extraction, to the extent of desirable physical and chemical changes. In addition, agroindustry is also defined as a part of manufacture sector, enabling to convert raw materials and intermediate products originating from agriculture, fisheries, and forestry. Besides, agroindustry closely relates to production of products mainly derived from plants and animals [14], [15]. The main ingredients of these products can represent product's features, in addition to the amount of the ingredient. Coconut agroindustry may provide a great contribution to value addition of the commodity. Hence, coconut-based agroindustry has received economic importance since most parts of coconut can be used for various meaningful products.

As mentioned, development stage is considered as attempts to reach further improvement, strategy for development of coconut agroindustry should represent the development pattern designed to integrate goals, policies, and actions of business organization cohesively, capable of reaching value addition to coconut as strategic commodity. Agroindustry down streaming, also known as value-adding, is expected to reduce export of raw materials, while rising development of downstream industries based on Indonesia natural resources, both renewable and non-renewable resources [16]. In short, down streaming of coconut agroindustry enables to nurture development of new products (produced by existing and new industries), while considering potential raw material, company's ability, and financial feasibility studies (financial, expert, equipment, and customer preference prediction). The down streaming itself aims to raise value addition, strengthen industrial structure, foster industry population, create employment and business opportunities as well as encourage domestic industries to use the raw materials, increasing the value added with creation of vacancies [17].

Based on aforementioned elaboration, intelligent decision-making system for development and

down-streaming of Agro-industry using system approach can be reached using interactive computer based on data, model, and expertise knowledge to support organizational decisions. The decisions are arranged in order to solve complex problems in context of coconut agroindustry, through combining artificial intelligent. The development and down streaming of coconut agroindustry are divided into three classes, i.e. upstream industry, intermediate industry, and down streaming industry [17]. Based on literature study, we also noted the study on development and down streaming of coconut agroindustry has been also carried out, covering from upstream to downstream.

Studies on upstream coconut industry are at the foremost stage, including fresh coconut, black and white copra. The research topics on upstream industry also discuss about model for measurement design of supply chain performance [18], value added [19], competitive analysis [20], and strategy for development of coconut agroindustry (Cocos nucifera) to increase farmer's income, and value chain [21]. Besides, research scopes on coconut industry also include raw material processing into derivative products such as coconut shell, copra meal, and desiccated meal. The intermediate derivative products provide economic benefits [22]and value addition [23].

On the other hand, research scope in downstream industry includes coconut processing, such as biodiesel [24], nata de coco[25], palm sugar [26], coconut oil [27], [18], liquid smoke [28] and various distinctive foods [19] for instance coconut water drink, coconut milk, and dried coconut, ketchup, palm sugar, and various non-food products (coconut fibre, coconut charcoal, oleochemicals, wood and activated carbon [29]). Other derivatives of coconut are known to have high economic value [30]such as virgin coconut oil, biofuels/bio lubricants, and cosmetics [31]. Hence, there is a need to determine the priority of coconut Agro-industry, analyse development of coconut derivative product business [30]and assess life cycle, as already carried out in active coconut charcoal [32], while it is also necessary to discuss the development strategies [8]. The strategy is needed to accelerate social economy [33], improve regional development [34], and escalate farmer's income and raise economic value of coconut through diversification at downstream level [34]. Considering internal and external factors is required in order to implement the developed strategies in coconut agroindustry [35].

Furthermore, the integrated research scopes collaborate entire aspects from upstream to downstream. Thus, value chain analysis on coconut agroindustry is highly essential to achieve more insights that are meaningful for industries to develop their competitive advantages and shareholder values [36]. For this reason, we need more discussion regarding to emerging issues, policies and programs significantly contributing to the value chains [37].

3. Methods

3.1 Critical review framework

This work categorized critical review into 5 main topics: decision support system in agroindustry development and decision support system in agroindustry down streaming, agroindustry development, agroindustry down streaming, and coconut Agroindustry. This work focused on approach and method applied to discuss the topic, while literature review framework is exhibited in Figure 1.

This study begins with elaborating the definition of decision-making system in development and down streaming of coconut agroindustry, identifying and analysing method and approach used in decision making system for agroindustry development, agroindustry down streaming, and coconut agroindustry, then followed by collaborating them. Furthermore, the next step is to criticize the method and approach used in the decision-making system and then develop framework model to collaborate decision making system in development and down streaming of coconut agroindustry.

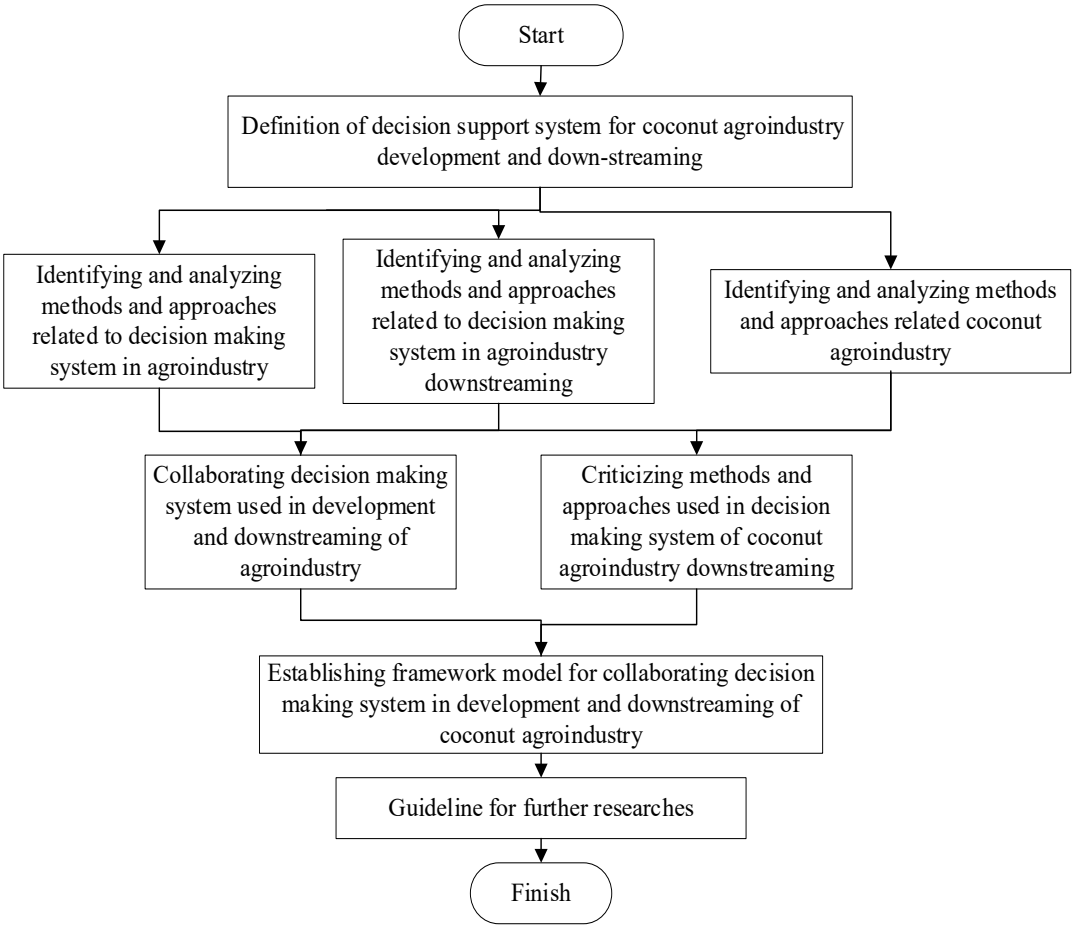

Figure 1. Framework and structure used in literature review

3.2 Article source and publication year

The article review was performed in 110 published articles covering the main topics. These articles comprised of journals, books and guidelines, dissertations, proceedings issued between 2010 – 2019. Distribution of articles based on main topics and publication year is presented in Table 1 and Figure 2.

Table 1. Number of scientific articles based on main topics

No	Main topics	Number
1	Decision support system in development of agoindustry	14
2	Decision support system in agoindustry downstreaming	3
3	Agoindustry development	34
4	Agroindustry downstreaming	14
5	Coconut agorindustry	45
Total		110

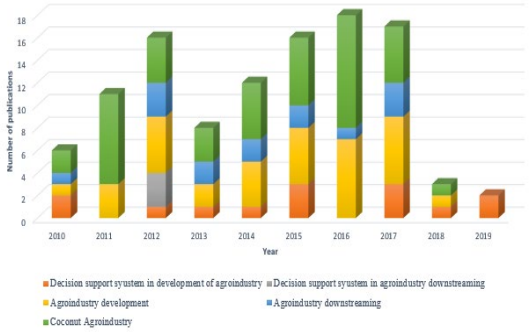

Figure 2. Distribution of articles by publication year

3.3 Distribution of reviewed journals

Identification of method and approach in decision making system for development and down streaming of agroindustry begins with classifying papers about decision making support system, agroindustry development, and agroindustry down streaming as described in Figure 3.

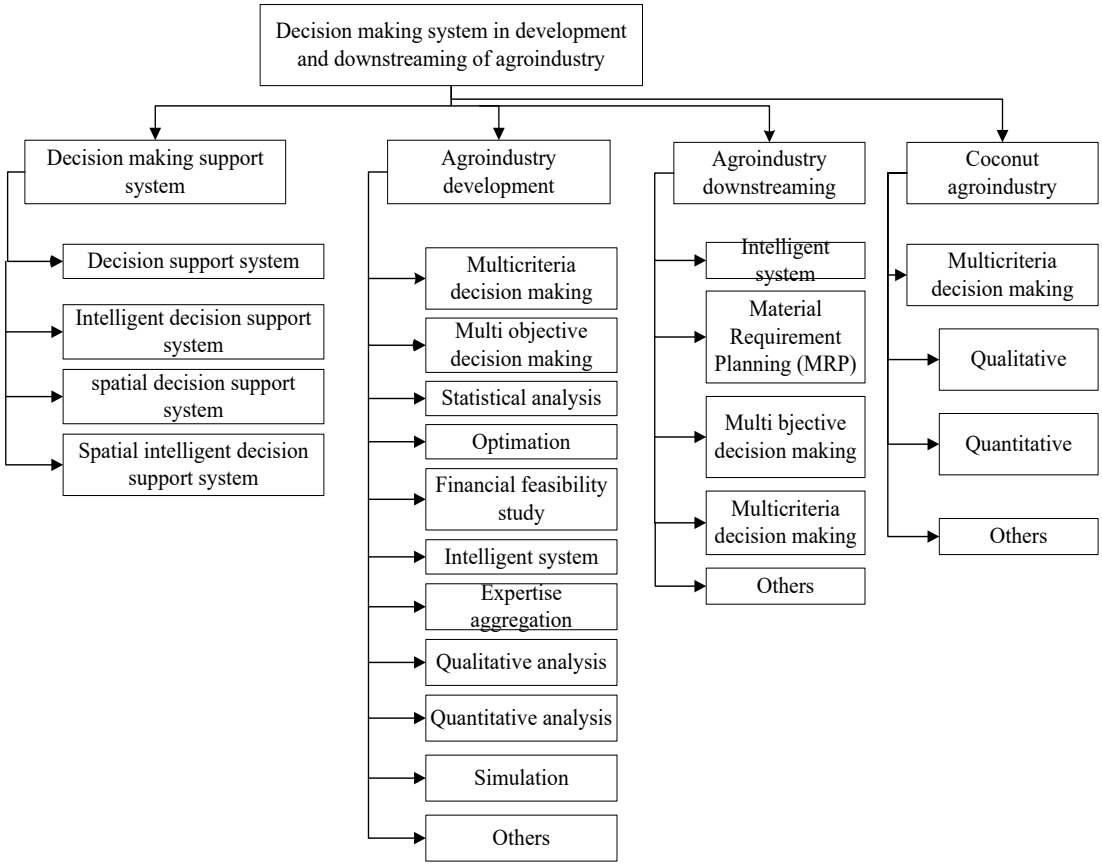

Figure 3. Group of methods and approaches used

4. Findings

4.1 Configuration of decision making support system

Decision making support system constitutes an interactive system or subsystem based on computer able to assist decision making process using communication technology, data, document, knowledge, and/or model able to identify and solve the problem, fix decision process tasks, and create decisions, thereby improving human or group capability to make or support the decision making process in a short period of time and high accuracy in presence of environmental changes. However, research pertaining decision support system in development and down streaming of agroindustry is rather scarce, particularly on Agroindustry down streaming. In fact, the decision support system has experienced a remarkable progress, such as intelligent decision support system, spatial decision support system and spatial intelligent decision support system.

Intelligent decision support system (IDSS) is the combination of decision support system and expert system, created to cope with limitations owned by each individual system. The IDSS in agroindustry has been applied in finding optimum route for bioenergy supply chain based on oil palm [38], production planning and inventory control (PPIC) adaptive in food industries [39], and tapioca industry [40].

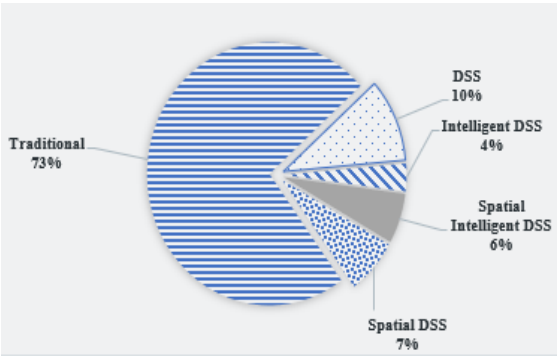

Figure 4. Configuration of decision-making system in development and down streaming of agroindustry discussed in literatures.

Spatial decision making exploited the geographical relationship in the data to create decision. Spatial decision support system (SDSS) combines many components, such as spatial data,

non-spatial data, analysis function, and geographic information system (GIS) visualization, decision model in a particular domain, enabling to calculate the characteristics of the solution, facilitate the evaluation of solution alternatives and trade-off assessment. Spatial data are connected to location, a place in the world. SDSS enables to offer significant contribution to many sectors including agriculture, business, civil engineering, environment and resource management, health care, transportation, and urban planning [23]. In development of downstream industry, determining the optimum location is a complex process since it involves interconnected aspects. Many of the aspects come with high uncertainty, thus SDSS approach is necessary to create strategic decision in order to improve competitive advantages [12]. Additionally, Intelligent Spatial Decision Support Systems (Intelligent SDSS) has been currently developed [4], integrating spatial analysis geographic information system (GIS) and fuzzy logic. Decision making system is significantly performed using traditional way, without using decision support system as depicted in Figure 4.

4.2 Method and approach for agroindustry development

Several methods in development of agroindustry have been massively researched (Table 2). Multicriteria decision making enables to make decision dealing with complex problems. In this case, numerous studies using AHP are reported in many cases, such as determination of product [41], [42] and location [42]–[45] strategy for agroindustry development system, selection of core industries, selection of institutional aspects [34], modelling the strength factors in cluster [46], impact of company development [47], and determination of priority in waste management [48]. The main advantages of using ANP are on its ease of combining interconnected elements and acomodating feedback mechanisms into decision making network [49], as found in some cases including determination of prospective agroindustry product and institutional system [50] and strategic planning on agroindustry development system [8] and policy selection [49].

Multicriteria decision making involves group learning process, in which the structural models are created to capture system complexity, based on patterns particularly designed using graphic and sentences addressed to a team assessment, or a researcher.

Table 2. List of method and approach used in decision making system for agroindustry development

Method group	Method or Approach	Sources
Multicriteria decision making	AHP	[34], [41], [42], [44], [45], [46], [47], [51]
	ANP	[8], [49], [50]
	ISM	[45], [49], [55], [56]
	MPE	[45], [53]
	Vikor	[51]
	TOPSIS	[51]
	SCOR	[18], [54]
	ISDSS	[55]
	SDSS	[51], [56], [57]
Multi objective decision making	Heuristic	[48]
	Fuzzy Pairwise Comparison	[40]
	Artificial neural network	[40]
	Expert system	[40], [50]
	Fuzzy AHP	[54], [58]
	Fuzzy Logic	[59], [55]
	OWA	[40], [48], [51]
	Fuzzy simple additive weighting	[55]
Statistical analysis	Linier regression	[41]
	Correlation	[60]
	Cluster analysis	[50], [60]
	Descriptive statistics	[61]
Feasibility study	NPV, IRR, PBP, and Net B/C	[30], [34], [41], [42], [45], [48], [52], [53]
Qualitative analysis	SWOT	[8], [9], [33], [53], [54], [58], [61], [62], [62],
	Descriptive analysis	[8], [55], [67], [69]
	Tabular techniques	[61]
Others	Threshold risk analysis	[40]
	location quotient	[41], [42]

	GIS	[44], [51], [55]–[57]
	Positivistic paradigm by using explanatory research	[66]
	Cyber-Physical Systems	[67]
	SSM	[68]
	A'WOT	[7], [34]
	Agent-based approach	[69]
	Porter's 5 forces	[55]
	Benchmarking	[7]
	SSM	[48]
	Balanced Scorecard	[61]
	Explanatory research	[66]
	System Dynamics	[69], [70]
	Review	[71]–[77]

4.3 Method and approach for agroindustry down-streaming

Based on literature review, numerous studies on method and approach for agroindustry down streaming have been extensively discussed (Table 3).

Intelligent system used is Fuzzy Multi Objective Linear Programming, Expert system, and artificial neural network. Using Fuzzy Linear Programming (FLP), resource variables can be uncertain (fuzzy), while variables used in linier programming in non-fuzzy (crisp Linear Programming) are fixed number in approximation with the real condition. In factual situation, the uncertainty may exist due to environment and supplier factors affecting main production schedule [39]. Artificial neural network (ANN) is a processing paradigm of information, adapted from biological neural system in human brain. It constitutes one of information processing systems able to imitate the mode of action of the brain in dealing with problems while also able to learn as response to the changes through modification of synaptic weight, producing a better prediction of product successfulness [28].

Table 3. List of method and approach used in decision making system for agroindustry down streaming

Method group	Method or Approach	Sources
Intelligent system	Fuzzy Multi Objective Linear Programming	[39]
	Artificial neural network	[28]
Material Requirement Planning (MRP)	lot sizing Economic Order Quantity (EOQ)	[39]
	Continuous Review System	[39]
Multi Objective decision making	Flowshop Genetic Algorithm	[39]
	MIP	[82]
	Heuristic	[82]
	Metaheuristic	[82]
	Multi-objective Evolutionary Algorithms	[83]
Multicriteria decision making	Pair comparison	[28]
	Bayes	[28]
	Spatial Multi Criteria Decision Analysis	[10]
	AHP	[80]–[82]
	ANP	[79]
Others	Delphi	[28]
	Spatial Simulation	[10]
	GIS	[10],
	CGE comparative static	[84]
	LCA	[85], [86]
	ANOVA	[87]
	Case Study	[88]
	Descriptive analysis	[89]
	Review	[16]

4.4 Current issue on methods and approaches in development and downstreaming of coconut agroindustry

Table 4 presents variation of methods and approaches used in agroindustry down streaming. Multicriteria decision making involves some methods and approaches such as pair comparison, and AHP. AHP is employed to determine agroindustry, prospective product and location as well as analysis on the most proper institution for coconut agroindustry [34].

Quantitative analysis is used to evaluate the value addition [20], [23]–[25], [90], [91] potential and competitiveness [20]. Qualitative analysis is employed in combination with descriptive-qualitative analysis. Descriptive-qualitative

analysis is used to solve problems in value chain [18] and value added [93]. Meanwhile, financial feasibility study is employed to calculate NPV, IRR, PBP, B/C Ratio, and Net B/C [30].Other methods and approaches are applicable for determining location using location questions method, while literature review is used to discuss decision making process regarding to coconut agroindustry.

Table 4. List of method and approach used in decision making system for coconut agroindustry

Type of Method	Method or approaches	References
Multicriteria decision making	Bayes	[93]
	AHP	[34]
	ANP	[8]
	SCOR	[18]
Qualitative	Descriptive analysis	[18], [36], [37], [64], [92], [94], [95]
Quantitative	Descriptive analysis	[20], [23], [101], [27], [37], [92], [96]–[100]
Financial feasibility study	NPV, IRR, PBP, , and Net B/C	[30]
Others	Literature review	[19], [21], [103], [103]
	Hayami	[26]
	Dynamic simulation	[97]
	SWOT	[8], [33], [63]
	A'WOT	[34]
	Matrix Internal-External	[35]

Multicriteria decision making involves some methods or approaches, i.e. pair comparison, Bayes, AHP and ANP. The pair comparison and Bayes are used to design model for determining value and recommendation of a new product concept [28] as well as offering product diversification and investigating the acceleration of industry development of crude palm oil derivates in Indonesia using AHP [81], [82]. On the other hand, ANP is applied to evaluate system for action plan of downstream industry policy, since it enables to accommodate feedbacks between criteria, sub-criteria and alternatives [84].

Material Requirement Planning (MRP) involves some approaches, i.e. lot sizing Economic Order Quantity (EOQ) and Continuous Review System. EOQ is implemented for estimate the material requirement, while Continuous Review System is used in model for material requirement management.

Techniques in multi objective decision making include Flow shop Genetic Algorithm, MIP, Heuristic, Metaheuristic, and Multi-objective Evolutionary Algorithms (MOEA).

In addition, GIS (Geographical Information System) model approach and spatial simulation are also considerable in mapping all entities related to agroindustry system, from farm, downstream industry, and loading port [10]. It also enables to identify aspects and impacts to global environment due to production activities, as well as provide recommendation for improvement, while also encouraging the reduction of emission gasses. The sustainability of agroindustry supply chain was evaluated using life cycle impact assessment [86], [87].

5. Discussion

5.1 Research gaps and opportunities

Value chain of coconut starts from raw materials, production, marketing, to consumers[1012]. As depicted in Figure 5, the integrated researches covering from upstream to downstream sectors are less significantly carried out. Such researches are important in order to ensure availability of raw materials in upstream sector, while in downstream sector, they enable to improve customer's satisfaction [18]. Based on Appendix 1, most aspects seemed to be less considered; but, the foremost concern in down-streaming is development of agroindustry products which play significant role in future industries [104], improving the value-added [28]. Concept of agroindustry down streaming and regional development is highly crucial, not only for fostering economic growth, but also for creating employment and rising farmer's income. Therefore, potential regional mapping is inevitable to develop products based on regional characteristics, since agroindustry down streaming must be collaborated with people, which requires participation from local people. People empowerment serves significant roles in reaching their welfare, which should be carried out together with farmer's group; thus, agroindustry establishment is really from people, by people, and for people. In addition, the down streaming successfulness is also dependent on information related to feasibility analysis of

coconut industry [30]. Besides, discussion on the life cycle is also necessary [32].

With regard to decision making on development and down streaming of agroindustry, we considered not only research gaps, but also complex, dynamic and unstructured methods due to some factors, i.e. (1) perishability (susceptible to spoilage), (2) availability depending on harvesting, growth and season, (3) variation in end shape and size, and (4) voluminous. Therefore, there is a need for decision support system able to accelerate decision making process [3]. As depicted in Figure 6, the researches on coconut agroindustry are still dominated by traditional perspective, without using Decision support system. In addition, spatial indicators are needed [106], [107] to map potential regions for agroindustry down streaming.

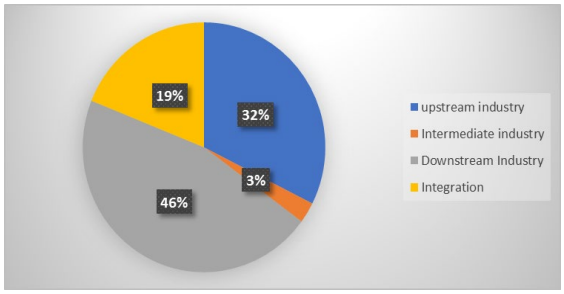

Figure 5. Research progress on coconut agroindustry

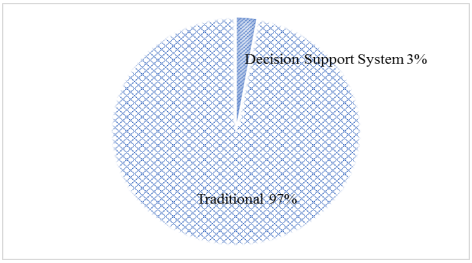

Figure 6. Configuration of decision support system in coconut agroindustry

Based on description above, we concluded that shorting the research gap is a necessary, while also considering relevant aspects required for decision making system in development and down streaming of coconut agroindustry. The aspect can be a integration of researches focusing mainly on potential region mapping, agroindustry product development model, institutional model as well as spatial decision making model [107].

5.2 Criticize methods and approaches for the development and downstreaming of coconut-based agroindustry

Methods and approaches used in development and down streaming of coconut agroindustry are grouped into multicriteria decision making, qualitative, quantitative, and others; specific classification of the methods and approaches is depicted in Figure 7. It is noteworthy that the methods and approaches are significantly applicable using descriptive analysis in order to evaluate development strategy. Yet, the method is actually possible to be integrated with multicriteria decision making such as ANP [8]. In addition, the research gap includes development of coconut through institutional sectors and agroindustry down streaming with production of new products while also considering location, product determination, and feasibility study.

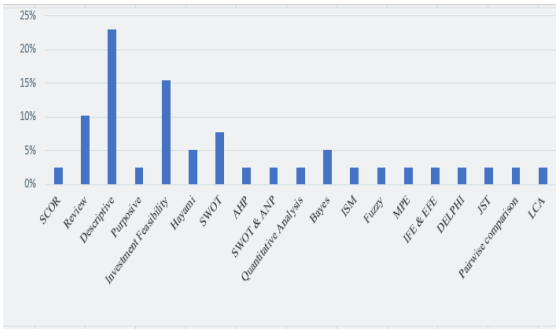

Figure 7. Methods and approaches used in development and down streaming of coconut agroindustry

Location needs to be determined carefully, since it closely relates to agroindustry sustainability. Current methods and approaches included multi criteria decision making using AHP. Some multi-criteria decision methods (MCDM) are now possible to integrate with GIS analysis [10], [108], [109], even combined with GIS and fuzzy systems for decision making [4]. In addition, product determination, in some studies, is carried out using AHP [15] and Bayes [67]. AHP can be combined with fuzzy [1], since the factual problems are often unsure in terms of information which is incomplete, inaccurate, vague, and indefinite. Additionally, feasibility study can be also carried out using fuzzy to obtain better result. Coconut development through institutional aspect using Interpretive Structural Modelling (ISM) [15].

Based on discussion above, it is important to notice that methods and approaches still require decision support system and spatial decision support system using multi objective decision-making method (MODM) and decision making using multicriteria decision making and intelligent system.

6. Guidleline for Further Researches

The integration between the development and down streaming of coconut agroindustry and the approach of smart spatial decision support systems makes it possible to improve efficiency and effectiveness in decision making in relation to coconut agroindustry. This approach is claimed to be the most satisfying concept because it makes the decision-making process faster. The research gap is as follows:

6.1. Research on integration from upstream to downstream coconut is rarely done as shown in Figure 5.

6.2. Appendix 1 shows that aspects of the model that are not considered in the downstream component of agroindustry are identification of supporting development and down streaming of coconut-based agroindustry, mapping of potential raw material areas, developing new products and developing coconut through equitable institutions.

6.3. The use of intelligent systems, multi-criteria decision making and multi-objective optimization as a method and approach in the study of coconut agroindustry which is still low is done as shown in Figure 6 and Figure 7. Agroindustry development and down streaming are hampered due to its complexity so that a spatial intelligent decision support system is needed.

Based on the research gap, we designed a framework for the development and down streaming of coconut ago-industry. The framework begins with the identification of structures that influence development and downstream, stakeholders, and business characteristics, mapping of potential areas, and coconut development models through the concept of institutional models. This concept is structured by identifying and organizing current institutional problems, analysing structural strengthening, or institutional improvement related to coconut development. In addition, the down streaming model starts from identifying new product ideas, determining new products, and conducting feasibility studies and life cycle analysis. Ultimately, this framework is used in the model into spatial intelligent decision support systems (SIDSS). The framework is presented in Figure 8, while the SIDSS configuration is illustrated in Figure 9.

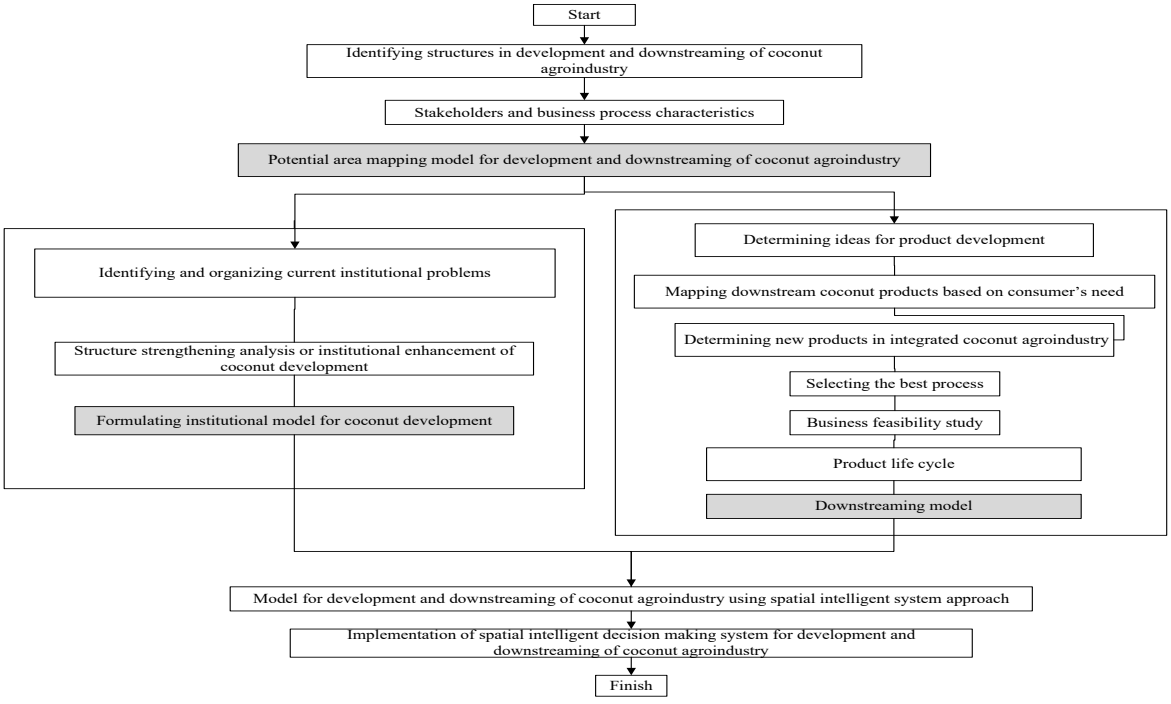

Figure 8. Guideline for further studies

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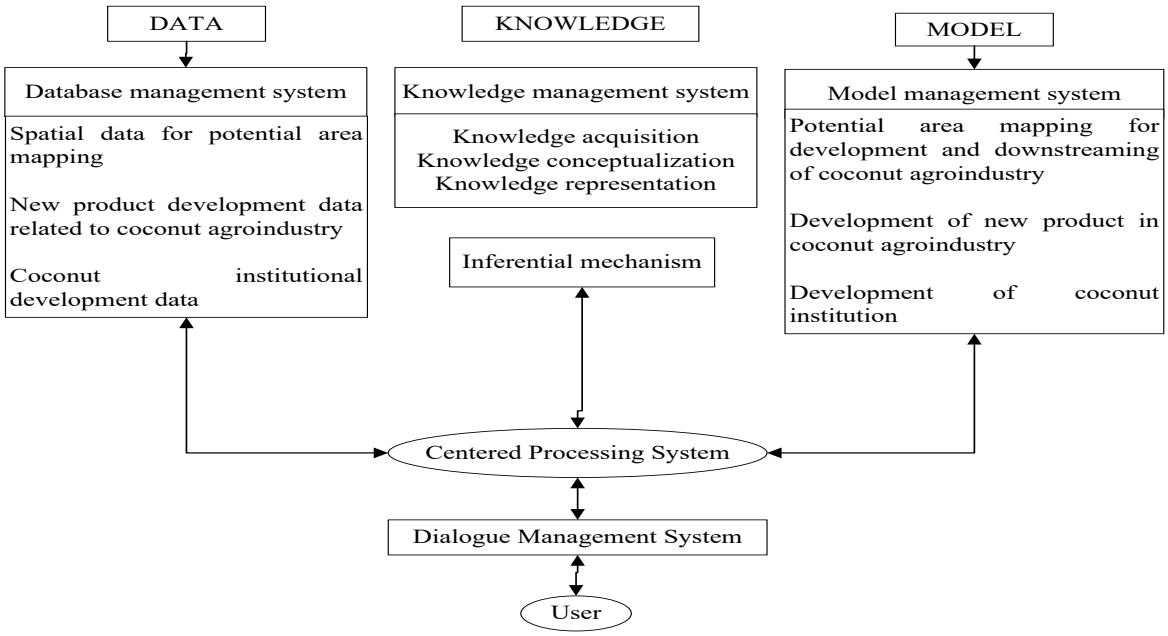

Figure 9. Configuration of SIDSS for development and down streaming of coconut agroindustry

7. Conclusions and Recomendations

This review has established and mapped the development and downstream of coconut-based agroindustry as a new concept in collaborative decision-making systems. This concept is fundamentally governed by the development of agroindustry and downstream as a basis and preliminary data to map the methods or approaches used for the development of downstream-based agroindustry. Our current work has been successful in reviewing and mapping the methods and approaches reported in various articles published in the past few decades and making suggestions for further research based on research gaps. As a recommendation, it should be noted that further studies are needed to find integration of coconut-based agroindustry development that is still low at around 3% and model aspects that need to be considered are the mapping of potential raw material areas, new product development and coconut development through equitable institutions.

The method or approach of previous research on the development and downstream of coconut-based agroindustry is about 97% still using traditional decision-making systems. For this reason, the most potential research frameworks and methods include the application of spatial intelligent decision support systems that can provide a fast and effective decision-making process. This approach is very important because coconut-based agroindustry is complex and unstructured. Finally, the development and down-streaming of agroindustry can be carried out with more advanced approaches.

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Appendix 1. Considerable model aspects in development and down streaming of coconut agroindustry

No	Author (s)	Tittle	Industry Topic				Model aspects																									
			1	2	3	4	Down streaming									Development																
							A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	[18]	The Design of Models for Coconut Oil Supply Chain System Performance Measurement	x																				X									
2	[19]	Coconut: An extensive review on value added products			x																	X										
3	[24]	Commodity Chain and Value Addition of Biodiesel Production from Coconut in Philippines	x		x																	x										
4	[20]	Competitiveness Analysis of Coconut Commodities in Kupang District	x																x													
5	[95]	Analysis of Income and Added Value of the Coconut into the Copra in the Bolubung Village of North Bulagi subdistrict of Banggai Islands Regency	x																			X										
6	[25]	Added Value Analysis and Feasibility Study of Nata De Coco Agroindustry in Ketapang Districs West Borneo			x				x													x										
7	[64]	Strategies and Implementation of Development of Future Coconut Products	x	x	x	x								x												x						
8	[96]	Development of integrated coconut processing for			x									X												X						

		small enterprises in villages																												
9	[30]	Analysis on business development of coconut derivatives in Jambi Province			x				x								x	x												
10	[22]	Development of Economic Potential an integrated coconut processing to Improve Welfare coconut farmers society in North Buton Regency		x					x																					
11	[63]	Strategy for development of Nata de coco agroindustry in Indragiri Hilir												x											x					
12	[33]	Strategy for development of coconut agroindustry in order to accelerate local community economy in Ketapang			x									x											x					
13	[8]	The Development Strategy of Coconut Sugar Industry			x									x											x					
14	[34]	Development Strategy of Agribusiness and Agro-Industry of the Coconut in the Regional Development of Padang Pariaman Regency			x				x		x			x					x						x				x	
15	[35]	Influence of Internal and External Factors Towards to Development of Coconut Industry in Indragiri Hilir District			x																									
16	[36]	Value Chain Analysis of the Coconut Sub-sector in Kenya				x														x										
17	[37]	Competitiveness of Coconut Wine Value Chain in the Coconut Industry in Kenya				x														X										
18	[21]	Value Chains of Agricultural Commodities and their Role in Food Security and Poverty Alleviation – A Synthesis	x																	X										
19	[102]	Value Chain Analysis of				x				x										x										

		Coconut in Orissa Niraj																												
20	[26]	Value Added Analysis of Coconut Sap at Palm Sugar Agroindustry (Case at Palm Sugar Agroindustry, Karangrejo Village District of Garum, Blitar)			x			x												x										
21	[23]	Performance and Added Value of Coco Fiber Agroindustry in Kawasan Usaha Agroindustri Terpadu (KUAT) at Pesisir Selatan Sub-District of Pesisir Barat District			x															X	X									
22	[20]	Analysis on coconut commodity competitiveness in Kupang	x																	x		x								
23	[92]	Analysis on productivity and added value of Kelapa Rakyat (A case study in 3 sub-districts in Halmahera Utara)	x																	X			X							
24	[98]	A Study on the Prospects of Neera as an Agro-Based Industry	x																			X								
25	[93]	Marketing Strategies for coconut and its value-added products North-East				x									X					X										
26	[27]	Value added products from Coconut oil	x												x					x										
27	[37]	Competitiveness of Coconut Wine Value Chain in the Coconut Industry in Kenya	x																X					x	x	x	x			
28	[94]	Model Design of Supply Chain for Small Scale Enterprise Integrated Coconut Industry				x																								
29	[110]	Determination of prospective product to develop integrated coconut agroindustry		x																										
30	[28]	Intelligent decision support system for selecting concept			x		x																							

		of new product development of liquid smoke from coconut shell																													
31	[32]	Life Cycle Assessment of activated carbon production from coconut shells			x						x																				

Description: Industry Grouping: 1. Upstream Industry, 2. Intermediate Industry, 3. Downstream Industry 4. Integration, A. New Product Development, B. Prospective product determination, C. Feasibility study, D. Supplier, E. Agroindustry Determination, F. Life Cycle Assessment, G. Location determination, H. Development strategy, I. Supply chain, J. Value Add, K. Development Impact, L. Barriers, M. potential and competitiveness, N. Commerce, O. value chain, P. Types of value-added products, Q. Performance, R. Profitability, S. Productivity, T. Strategy development, U. Distribution and Transportation, V. Price equality, W. Institutional, X. handling environmental impacts, Y. Potential Mapping of Raw Materials, Z. Product Performance.