STRATEGIC FOOD RISKS – CHILI'S AGROSYSTEM PERSPECTIVE

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Abstract: The prices of strategic food commodities, namely rice, red chili, chicken, beef, shallots, eggs, sugar, and cooking oil, are monitored to measure Indonesia's inflation in the food category. This study intended to explore the chili agrosystems as an essential Indonesian daily cuisine due to its perishable nature and its variably supply chain. The state-of-the-art approach from various research databases was used and supplemented with secondary data gathered from the related enterprise. The study revealed that food strategic web-based information systems on production, consumption, and price are under different authorities. Concerning the chili case, even though there was a production surplus, price fluctuation increasing the risk of lowering motivation to plant. The number of actors involved itemizes eight chili's supply chain main patterns. In conclusion, chili trade and freight margins favoured supply chain actors but not the farmer itself. The welfare of the farmers is not good condition. It is characterized by proxy indicators, the majority of which are only slightly more than 100. The situation creates a new risk of decreasing motivation in farming. Further study using manageable chili enterprise systems is required to bring farmers closer to end consumers and improve their welfare.

Keywords: chili agrosystem, decision support system, enterprise system, strategic food, supply chain

Abstrak: Inflasi Indonesia pada kelompok pangan dipantau melalui harga komoditas pangan strategis, yaitu beras, cabai, ayam, daging sapi, bawang merah, telur, gula pasir, dan minyak goreng. Studi ini bertujuan untuk mengeksplorasi sistem agrosistem cabai sebagai bumbu makanan pokok Indonesia sehari-hari karena sifatnya yang mudah rusak dan rantai pasokannya yang panjang. Pendekatan state-of-the art berbagai database penelitian digunakan pada studi ini dan kemudian dilengkapi dengan data sekunder yang dikumpulkan dari enterprise terkait. Hasil studi mengungkapkan bahwa sistem informasi pangan strategis berbasis web mengenai produksi, konsumsi, dan harga cabai berada di bawah otoritas yang berbeda. Setiap komoditas pangan strategis menjalankan rantai pasokan yang berbeda. Pada kasus cabai, meskipun terjadi surplus produksi, namun fluktuasi harga meningkatkan risiko penurunan motivasi petani untuk bertanam. Selain itu, terdapat delapan pola utama rantai pasok cabai yang dirinci berdasarkan jumlah pelaku dalam rantai pasok. Sebagai kesimpulannya, perdagangan cabai dan margin pengangkutan lebih menguntungkan pelaku rantai pasok namun bukan pada petani itu sendiri. Kondisi kesejahteraan petani kurang baik, yaitu ditandai dengan indikator proksi yang mayoritas hanya sedikit di atas 100. Kondisi tersebut menimbulkan risiko baru berupa penurunan motivasi petani dalam bertani. Studi lebih lanjut dengan menggunakan sistem usaha cabai fleksibel diperlukan untuk mendekatkan petani dengan konsumen akhir dan meningkatkan kesejahteraan para petani.

Kata kunci: agrosistem cabai, sistem pendukung keputusan, sistem enterprise, pangan strategis, rantai pasok

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INTRODUCTION

Chili is considered a perishable plant that will only be fresh for about 1-2 weeks and, after that, will deteriorate. Indonesia's strategic foods are rice, chili, chicken, beef, onions, eggs, granulated sugar, and cooking oil. Lin et al. (2015) stated that one-third of perishable food (fruits and vegetables, tubers, fish and seafood, meat, milk) losses when transported to the destination. The loss variations occur during planting, harvesting, and many other aspects. Hence, there is no generic model that applies to all types of perishable food. When transporting, it is imperative to consider the optimal amount of fruits and vegetables transported in one trip to the destination to produce a maximum profit (Armenta et al. 2016).

The efficiency of chili production in Ghana is 65.76% economically efficient, 70.9% technically efficient, and 92.65% allocation efficient (Asravor et al. 2016). The availability of chili can be affected by pests and diseases of chili. Mariyono (2017) showed that yield losses due to pests and diseases are quite large and can even be catastrophic. Moreover, chili farmers' chili agribusiness risks include production, price, financial and institutional risks (Hidayat 2017). The risks that include negative impacts for chili farmers are production risks due to crop diseases, market risks due to price volatility, and financial risks.

Budiastuti et al. (2017), Chen Van et al. (2017), Anggraeni et al. (2018), Nuvaisiyah, Nhita, and Saepudin (2019), Hasmita et al. (2019), and Nurcahyono et al. (2019) carry out chili prices studies. Furthermore, Kementerian Perdagangan (2016) states there are two price disparity conditions, first inter-time disparity. These are national monthly price variations within three months. Secondly, the disparity conditions between provinces are explained by the coefficient of variation in chili prices in January-December. If the chili price homogeneous and the provinces' price variation small, the variation coefficient will be less. On the other hand, if chili's price is heterogeneous or the price difference between provinces differs more, then the variation coefficient will be more prominent.

Meanwhile, studies related to fresh produce supply chains, including chili, have been conducted by many researchers. Most chili supply chain actors face several obstacles: losses, reduction of products, and inefficiencies in delivery time (Perdana et al. 2018).

Therefore, chili's lean product development requires integrated action from all stakeholders involved in the production process (upstream to downstream processing). Villalobos et al. (2019) described the logistics of fresh produce in real-time, suggesting the development of joint statistical-estimation models and supply chain planning in an integrated or hierarchical manner by utilizing opportunities presented real-time information sources. The study of Barusman et al. (2019) states that the chili supply chain is still quite long and has not been optimized, including empowering the Village Owned Enterprises (called Bumdes) and the Indonesian Farmers Shop (called TTI). These have become one of the triggers for rising chili prices.

Our study is part of developing smart enterprise systems to monitor chili's production and consumption. The first step towards creating the chili smart enterprise systems recognizes its valuable practices and its attributes. The methods and features influence the success of the state-of-the-art of chili agrosystem. Hence, our study intends to characterize the efforts and attributes that construct the chili agrosystem as being effectual. The information could enhance the developed chili enterprise architecture. That is by specifying specific information on the chili agrosystem application practices. Furthermore, it indicates the measurement application approaches use by the chili supply chain actors. In particular, our study is concerned about:
a. Investigating constraint and challenges in the available chili agrosystem.
b. Recognizing the use of web-based systems by the existing chili agrosystem.
c. Recognizing open challenges and areas for enhancement.

This study's primary audience for this state-of-the-art is twofold. First, we target researchers interested in a state-of-the-art status of the field of chili agrosystem, especially they are interested in the implementation and attributes of an effective chili agrosystem. Lastly, we aim at the individual or group of chilies' farmers who are keen to find out effective chili agrosystem to improve their exchange rates.

METHODS

Our study used a state-of-the-art (STA) approach year 2015-2020 publications. According to Miriam Webster's Dictionary, STA determines the level of development

(such as devices, procedures, processes, techniques, or science) achieved at a given time as a result of modern methods. This section illustrates the foundation of this STA by defining the STA research questions and search keywords. This research hypothesizes that chili agrosystems in Indonesia face many problems characterized by farmers' many risks due to asymmetric information.

Chili agrosystem implementation from land to the table is not a new problem. Various methods and approaches have offered to portray exercises in application of chili agrosystem. Our study aimed to ascertain particular systems or attributes that influence chili agrosystem efficacy. We aimed at the current issues of chili agrosystem, particularly, to answer the following research questions:

RQ1. What are the effective chili practices suggested in the chili agrosystem?
RQ2. What are the attributes contributing to chili farmers' welfare valuable?
RQ3. What does the chili agrosystem use web-based information systems?

In this research, the term 'agrosystem practices' denotes a series of actions and procedures to characterize, advance, and preserve the delivery of fresh produce from farmers or groups of farmers to end consumers from the agribusiness perspective. The term 'attribute' refers to the success or quality factors that affect farmer welfare measurement. The term 'effective agrosystem practices' mean activities and procedures that give considerable assistance to the chilli agrosystem's effectiveness.

The search process is carried out by searching various relevant articles through six research databases (Figure 1), namely Google Scholar (www.scholar.google.com),

ACM Digital Library (http://portal.acm.org), IEEE Xplore (http://www.ieee.org/web/publications/xplore), Science Direct- Elsevier (http://www.sciencedirect.com), Springer Link (http://www.springerlink.com), and Taylor and Francis (www.tandfonline.com) published between 2015-2020.

Our study defines the construct and guidelines for managing the STA as follow: Inclusion criteria (English peer-reviewed journal papers and conferences proceeding). Exclusion criteria (Book Chapter, Indonesian peer-reviewed studies, unrelated articles to the STA questions, redundant research (by title and content), and brief paper (e.g. poster)).

For the exclusion criteria, candidate articles that are not a specific procedure and process for chili irrelevant in this research setting. Our study intends that our STA should concentrate on practices and factors of chili agrosystems. Table 1 present the application of the search criteria based on the keywords depicted in Figure 1. Table 2 showed the citations of selected 39 papers obtained using Google Scholar.

RESULTS

Our study identified 24 research methods out of the selected 39-literature concerned over the year 2015-2020. The findings indicate the complexity of the chili agrosystem showed in various approaches. We also noticed the unavailability of a comprehensive dataset about chili management and operationalization. The year 2017 publication utilizes the highest number of methods, followed by 2019 and 2020 (Figure 2). Figure 3 depicts that of all literature assessed; the most frequent words are chili (2,085 times), followed by farmers (1,365 times), production (1,333 times), food (1,156 times), price (1,060 times), and supply (854 times).

Table 1. Studies retrieve over search engines[a]

Source	Paper Found	Candidate	Selected
Google Scholar	57	42	29
ACM Digital Library	42	11	3
IEEE Xplore	1	1	1
Science Direct – Elsevier	58	5	1
Springer Link	43	3	-
Taylor and Francis	84	8	4
Total	285	70	39

[a] Search process conducted in October 2020

Table 2. Selected paper citation

Reference	Cited	Reference	Cited	Reference	Cited
Alexander et al. (2017)	12	Ibarrola-Rivas and Galicia (2017)	9	Perdana et al. (2018)	0
Andayani et al. (2016)	6	Indriani et al. (2020)	1	Putri et al. (2020)	0
Anggraeni et al. (2018)	0	Karyani et al. (2015)	9	Rachmaniah et al. (2020)	0
Armenta et al. (2016)	0	Karyani et al. (2020)	0	Ridwan et al. (2017)	0
Asravor et al. (2016)	13	Kumashiro et al. (2015)	1	Runtuk (2019)	0
Barusman et al. (2019)	2	Kusdiartini et al. (2017)	2	Saidah et al. (2020)	1
Budiastuti et al. (2017)	6	Li et al. (2015)	18	Sitthisuntikul et al. (2018)	7
Chen Van et al. (2017)	0	Lin et. al. (2015)	12	Soepatini et al. (2018)	17
Fountas et al. (2015)	189	Mariyono (2017)	6	Sukmawati & Dasipah (2020)	0
Hamilton-Hart (2019)	12	Mariyono (2018)	23	Villalobos et al. (2019)	5
Hasmita et al. (2019)	1	Novitasari & Setyawan (2019)	1	Wardhono et al. (2020)	0
Hidayat (2017)	2	Nurcahyono et al. (2019)	2	Yin & Wang (2017)	1
Hu et al. (2017)	0	Nuvaisiyah et al. (2019)	3	Zhong et al. (2015)	25
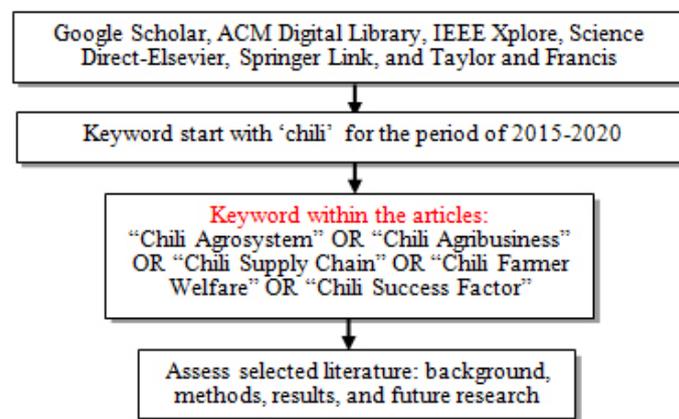
Figure 1. The search flow of keywords in various research databases
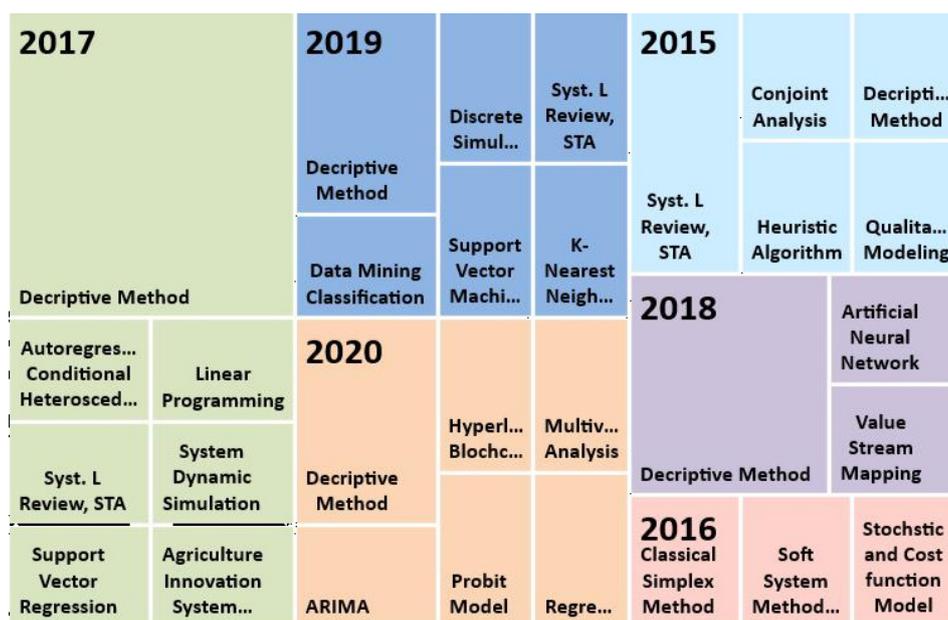
Figure 2. Numerous research methods used by year of publication
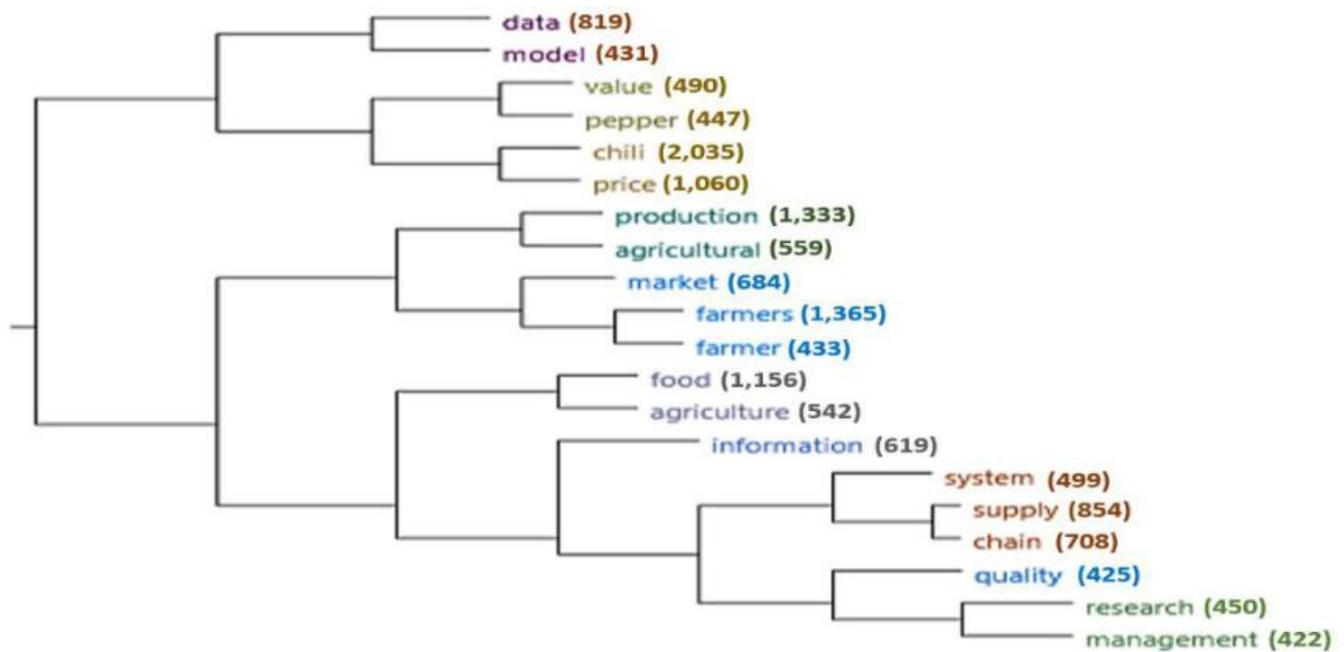
Figure 3. Clustered twenty most word frequency query results

General Discussions

This section emphasis more on the recent chili agrosystem tackled or stated in the selected primary studies. Indonesia's chilli agrosystem issues arise from farmer/farmer group (the producers), scattered production centre, price disparity, supply chain actors, data and information segregation, supply chain management, and government intervention. According to Karyani et al. (2015), a food self-sufficiency program embraces agricultural and land policy, meaning it provides especially strategic food practices to meets national consumption. Regardless of the agriculture political economy, it requires producer subsidies (fertilizer, loan, and seeds), price support (mandated price floors), and tariff protection. Yin and Wang (2017) added that food security solutions should be site-specific, considering the ecological, socioeconomic, and cultural situation with a bottom-up approach. Farm management information systems (FMIS) must provide tools to reduce production cost, conform to agricultural standard, and uphold high product quality and security benefit (Fountas et al. 2015). The FMIS must reflect the human-related nature of business processes, especially for marketing/sales and supply chain roles, where social aspects have greater relevance. Nevertheless, agricultural information systems often fail due to insufficient and different comprehension of farmers' and vendors' information needs, information sources, and sharing strategies (Ridwan et al. 2017). Therefore,

best practices on supply chain management positively impacted competitive benefit and firm performance (Sinaga et al. 2021).

RQ1. What are the effective chili practices suggested for the chili agrosystem?

To answer the first research question, we develop ten attributes of effective practices. These attributes include crop rotation, investor contract, marketing, partnership, quality management, risk, security, supply and demand, and supply chain. We analyzed RQ1 attributes and methods employed to investigate which research method falls in each RQ1 attribute's (Figure 4). Regarding the research methods used, we noticed that the security and supply chain use the highest quantity of research methods (6 research methods) followed by the supply and demand (5 research methods). The remaining attributed utilizes between 1-3 research methods. Notice that three articles exercised the same research methods on the attribute of security, supply chain, and partnership. These research methods are systematic literature review/state-of-the-art (SLR, STA) and descriptive methods.

RQ1 relates with effective chili practices for the chili agrosystem; hence, we create its attributes as asserted in analyses. Chili is a non-complementary vegetable that cannot switch with dried chili or processed chili. Chili consumption is in the form of fresh chili. In

Indonesia, chili farmers believe that they cannot force to plant unless they get incentives. This condition triggers supply and demand discrepancy and different supply chain patterns. We observe that over-supply often occurs in May-July and under-supply occurs in October-January. The number of actors (entities) involved in the chili supply chain contributes to the supply chain's complexity. These actors consist of producers, retailers, collectors, wholesalers, agents, sub-distributors, distributors and importers, and exporters (BPS 2018). The BPS year 2018 survey in 16 provinces in Indonesia obtained eight main supply chain patterns encompassing variation of actors and number of actors in the chain. Note also that the leading supply chain pattern is dynamic and can be extended depending on production centres locations and behavior.

The attributes of RQ1 are following the results of previous researchers. Chili producers (farmers/groups of farmers) must consider the state of supply and demand in planning their production (Sukmawati and Dasipah, 2020; Putri et al. 2020). The supply chain operators involved in the distribution play an imperative practice in the chilli agrosystem's effectiveness (Novitasari and Setyawan, 2019; Indriani et al. 2020). Chili is at high risk differentiated by a drastic price increase if there is a chilli shortage (Hidayat, 2017; Sitthisuntikul et al. 2018; Mariyono, 2018; Karyani et al. 2020). Furthermore, chili producers must operate quality management to produce a quality product and gain market security (Kumashiro et al. 2015; Yin and Wang, 2017). Market assurance attained by having crop rotation, investor contracts, collaboration with structured markets, or some form of partnership (Li et al. 2015; Karyani et al. 2015; Wardhono et al. 2020; Andayani et al. 2016). Moreover, government intervention on the chili supply chain's profit value is required, including setting the price standard to narrow farmer and end customer price margin (Ridwan et al. 2017).
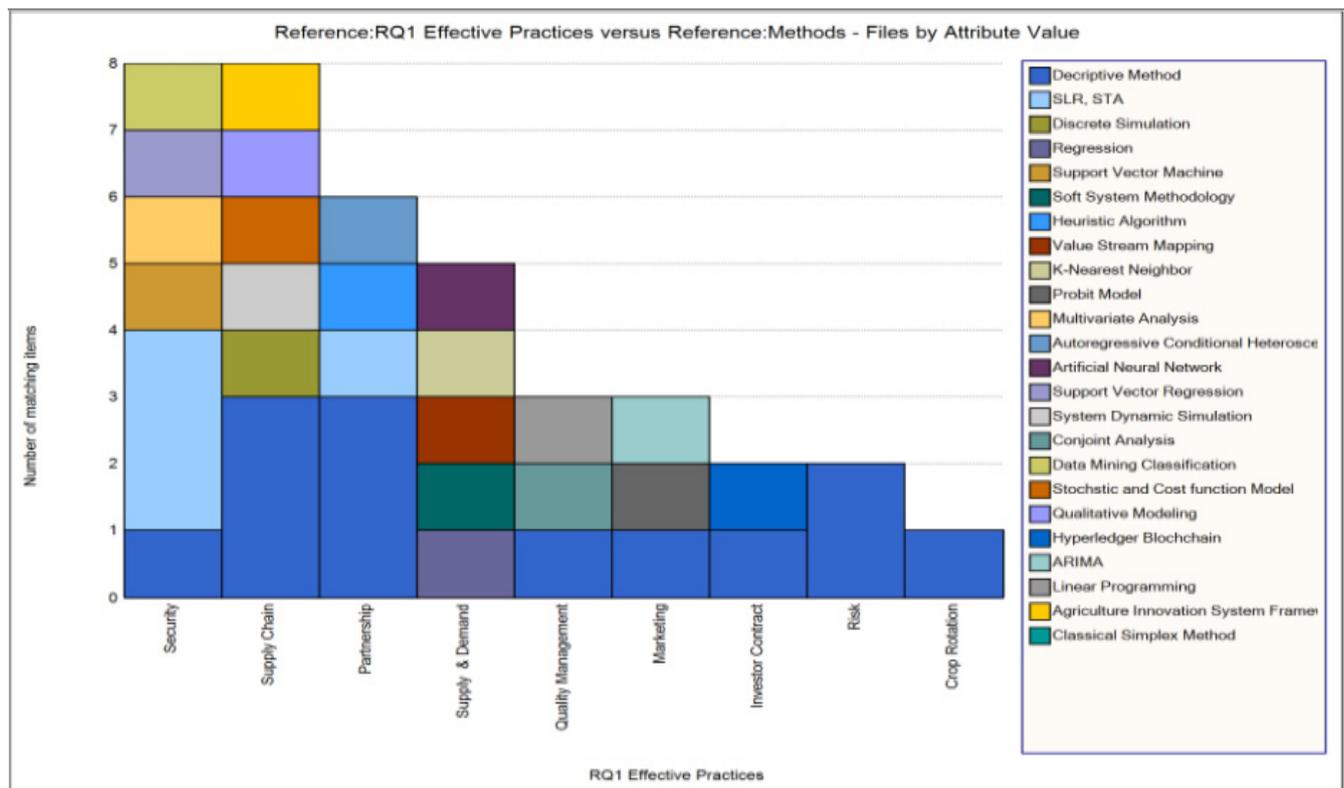
Figure 4. Relationship between RQ1 attributes and its research methods

RQ2. What are the attributes that make chili farmers' welfare valuable?

This RQ2 main concern is focusing on attributes that affect farmer welfare. The attributes selected for RQ2 are access market, commercial, economy, income, margin, operational cost, price prediction, profit, standard price, system cost, transportation cost, and yield. We believed that these attributes contribute to farmer welfare, especially access to market and profit. Figure 5 expressed that each RQ2 attribute's employed one particular research method except for economy and margin. Our text search query using NVivo 12 Plus software provided the number of the selected papers (denoted in parentheses) relates to the attributes mentioned above: access (27), market (35), commercial (10), economy (19), income (27), margin (10), operational cost (3), price prediction (3), profit (17), standard price (1), system cost (1), transportation cost (5), and yield (15).

Farmer exchange rates (FER) denotes proxy indicators for farmer welfare. FER compares the price index received by farmers with the price index paid by farmers (BPS, 2019). FER's purpose is to measure the ability to exchange products sold by farmers with products needed by farmers in household production and consumption. FER statistics reveal agricultural products' competitiveness compared to other products: FER > 100 means the farmer has a surplus, FER = 100 means the farmer breaks even, and FER <100 means the farmer has a deficit (BPS, 2019). In total, 16 provinces out of 34 Indonesia provinces have a FER value <100. The highest FER value in the January-March 2020 period was only 109.33. Overall, the average FER is 100.90, meaning that expenses and income are almost break even. It indicates that the increase in farmers' income is relatively minimal. Moreover, the majority of strategic food commodity farmers are small farmers with a minimum land area. This condition requires government policy intervention so that the welfare of farmers economically can be improved.
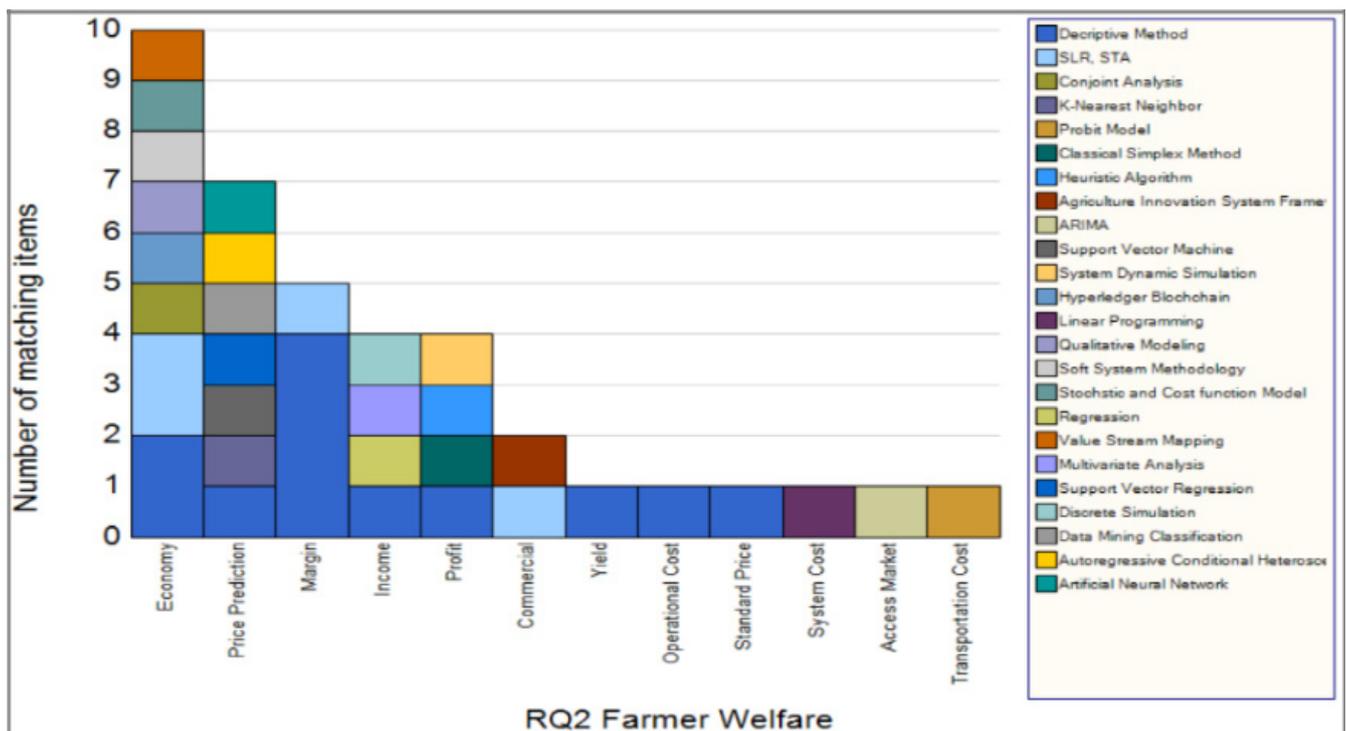
Figure 5. Relationship between RQ2 attributes and its research methods

RQ3. What does the chili agrosystem use web-based information systems?

Chili web-based information system accessed through mobile phone is supposedly providing comprehensive significant chili information for farmers individually or via its group of farmers. Through the website, farmers can make decisions on the planting schedule, market their products, transport fresh chili to end consumers, and access other relevant chili agribusiness aspects. Therefore, we develop RQ3 attributes: consumption data, information system, price data, production data, system cost, system framework, and website. Upon analyzing all selected papers, we found that very rarely research develops such a holistic chilli web-based system. Only seven articles suggest information systems as a pivotal element (Figure 6).

It is undeniable that data availability is essential for the benefits of economic, social, institutional, and environmental imperatives. Our text query using "primary" OR "secondary" OR "primary and secondary" OR "questionnaire" OR "interview" OR "focus group discussion" OR "survey" keywords returning 32 papers make use of the data. About ten articles used secondary data; the remaining studies uses primary data gathered through questionnaire, interview, observation, survey, or focus group discussion. The needs for recent all-inclusive integrated data are the foremost reasons for the primary data gathering approach. Rachmaniah et al. (2020) developed an application intended to record chilli production and distribution on supply chain actors but face data collection difficulties because of the Covid-19 micro-scale social restrictions.
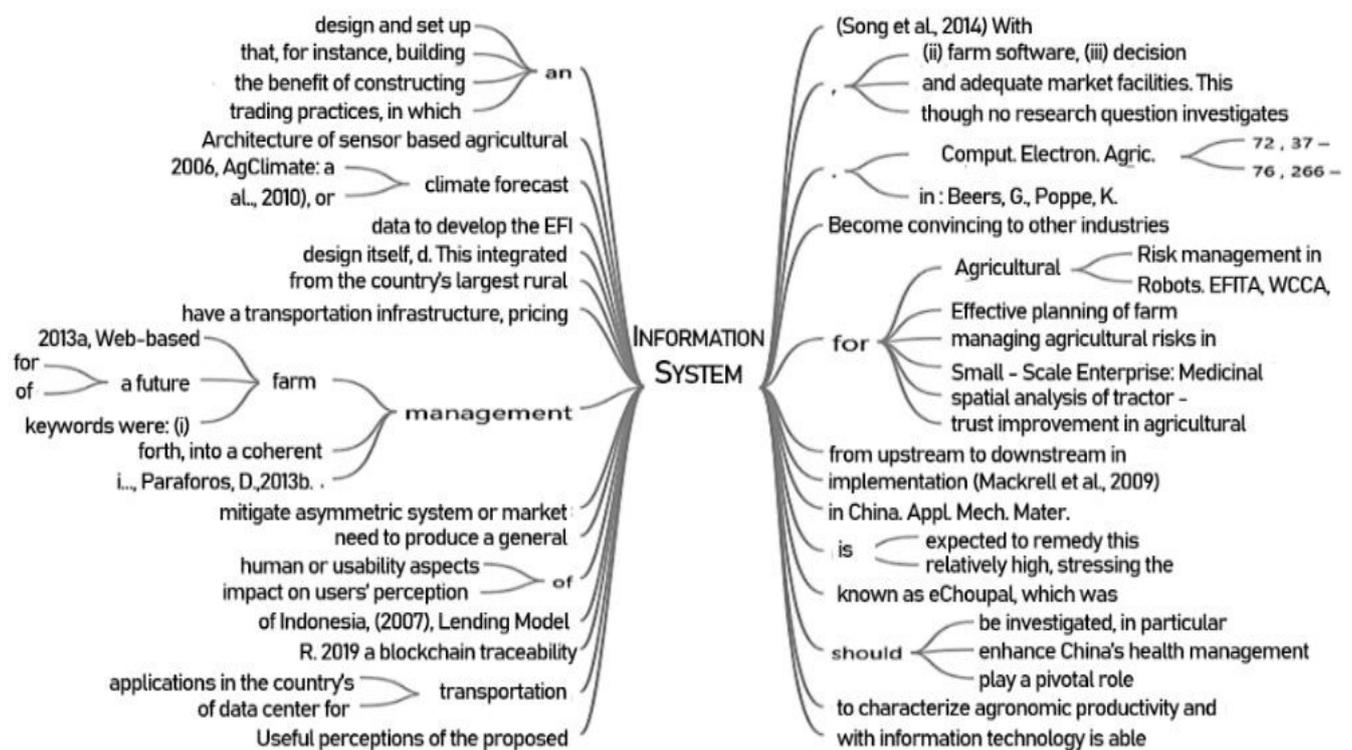
Figure 6. Information system word tree of the seven relevant papers

From a web-based chili agrosystem perspective, yield losses due to pests and diseases (Mariyono, 2017) data are necessarily aiming to assess the limiting factors in chili production. The efficient supply chain model is achieved by optimizing the existing institution (Barusman et al. 2019). In the meantime, price stabilization requires a determination of supply policy, which is the distribution at each supply chain level (Novitasari and Setyawan, 2019). In adition, data capturing along the supply chain can use hyper ledger blockchain (Putri et al. 2020), even though this is a new technology. The flow of price data along the supply chain recorded in the web-based agrosystem can give chilli producers feedback on where to market their products efficiently. The absence of price and comprehension information in the market has led to asymmetric information (Wardhono et al. 2020). Moreover, there are different perceptions among producers and vendors regarding their willingness to join a centre of agricultural data, information requirements, revealing strategies, and desired information bases (Zhong et al. 2015).

Fountas et al. (2015) reviewed 141 international commercial agricultural software packages categorized into 11 functions: field operations management, best practice (including yield estimation), finance, inventory, traceability, reporting, site-specific, sales, machinery management, human resource management, and quality assurance. These commercial packages sharpen on answering daily farm tasks and generating benefits for the farmers through better resource control and field operations planning. There exist three-layer agricultural conceptual frameworks for applying big data systems (Wolfert et al. 2017). These are the business process, the stakeholder network, and the network management layer. The business processes layer creates and uses big data for the management of agricultural practices. Some data chains cooperate with agriculture and management processes at this layer through different decision-making processes in which information offers an essential function. Thus, the enterprise system could act as a decision support system. The stakeholder network consists of all interested parties involved in the process, i.e., its users and providers who specialize in data management and regulatory and policy actors. Network management is the network's organizational structure and technology. It promotes the coordination and management of the processes conducted by actors in the stakeholder network layer.

Managerial Implications

The most significant risk that chili farmers often face during the dry season and the rainy season is production costs when planting and post-harvest marketing at prices that benefit farmers. Farmers must independently determine the selling price without being influenced by intermediary traders who often press the selling price. For this reason, the role of government banking in providing microfinance when planting and the role of partnerships with village cooperatives as marketing agents for farmers and liaising between farmers and the chili processing industry are vital. Therefore, village cooperatives must be managed more professionally, utilize balanced information, and provide adequate marketing facilities and infrastructure. As marketing agents, village cooperatives must act as a mini enterprise system at the village level. Microfinance and marketing agents that can always absorb farmers 'chili would improve farmers' welfare.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In conclusion, we registered current issues in the Indonesia chili agrosystem, as depicted in Figure 7. In general, these issues are in agreement with previous researches within the selected articles. It appears that Indonesia's problems also occur globally. There exist various possibilities for further studies concerning the chili agrosystem. According to the state-of-art and the answers to the RQs, we recommend some work lines, particularly if we consider some problems. Chili agrosystem involves many elements such as the array of producers worldwide, widespread supply chain actors, and diverse stakeholders plus the regulators.

Recommendations

Firstly, as elaborated in the results and discussions, the chili agrosystem's current problem that needs to tackle is split into three primary categories encompassing modelling, maturity, and preservation. Secondly, the identified attributes should be appraised and validated for a further lengthy period of a systematic literature review or state-of-the-art or even a survey. Thirdly, the chilli dataset's existence is of the utmost importance to overcome information asymmetry regarding economic, social, institutional, and environmental imperatives. It

could particularly integrate chili up-to-date data from various ministries and state and private agencies into the Indonesian Data in One Portal program, known as Data Indonesia dalam Satu Portal (https://data.go.id/). Lastly, the chili agrosystem requires an integrated enterprise architecture. Therefore, we suggest the development of chili architecture using some smart enterprise system framework for further study. The development of chili architecture aims to subdue understanding disagreements among farmers, supply chain actors, and stakeholders.

The study period is between 2015 and 2020 and hence does not embrace the whole state-of-the-art since its commencing. The search processes utilize the existing search engine on the specific prestigious online research databases. This manual search might miss some relevant papers intended for this study. We may also miss related research not issued in publications that are not indexing in the chosen databases, confidential technical reports, or closed and security articles.

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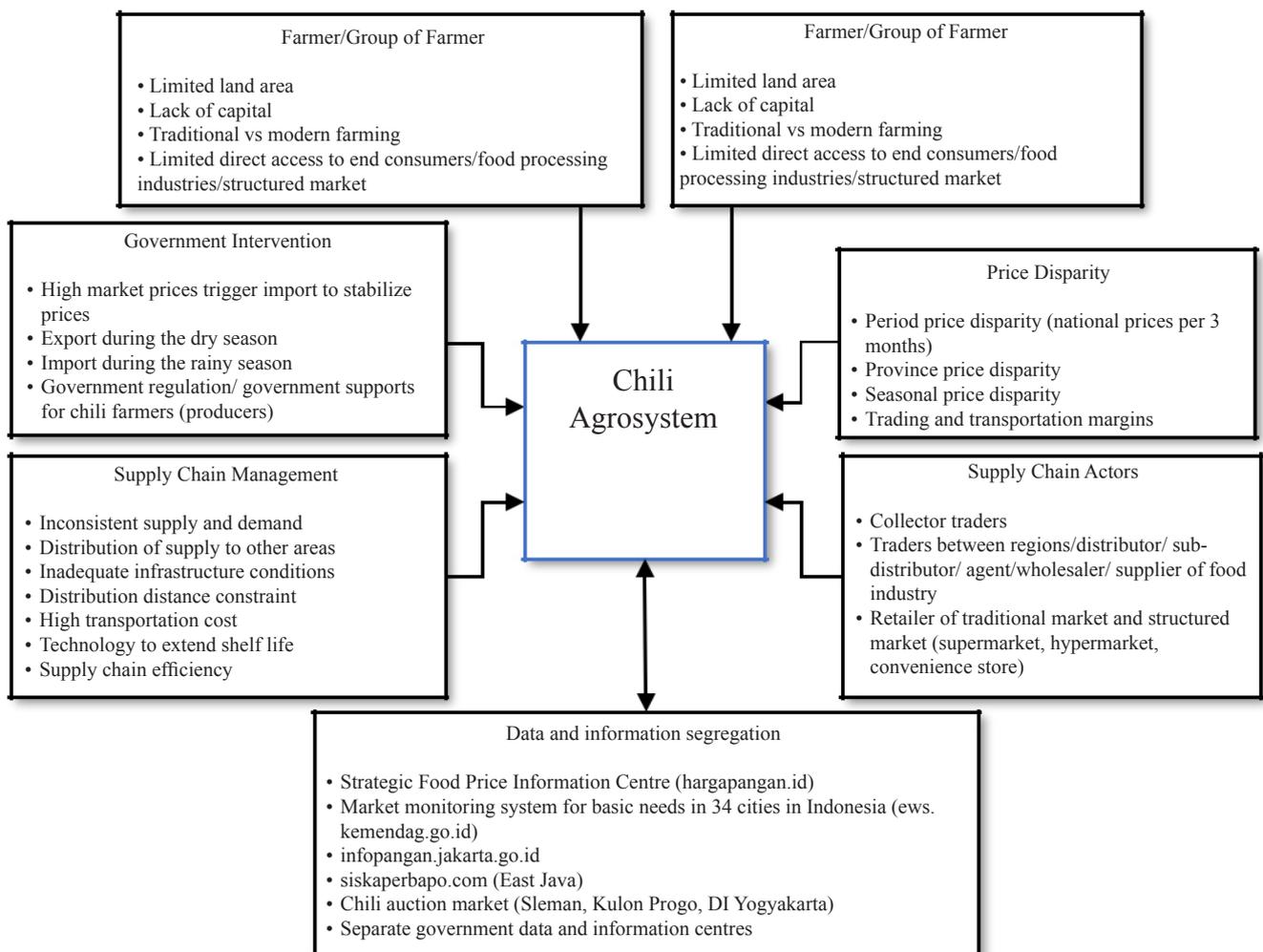
Figure 7. Identified Indonesia issues on chili agrosystem

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