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Review article

Risk management in the corn commodity supply chain as a raw material for sustainable poultry feed: A systematic literature review

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ABSTRACT

Corn is a strategic agricultural commodity due to its benefits and essential role in various sectors. It is not only used for food but also as a raw material for industries, including agro-industry and poultry feed. Approximately 40% to 50% of the raw materials for poultry feed are derived from corn. In the corn supply chain, fulfilling raw material requirements for poultry feed involves several risks that must be addressed, as they can impact the quality, quantity, price, and sustainability of corn. Therefore, it is crucial to identify existing risks, develop appropriate risk mitigation strategies, and implement effective supply chain risk management (SCRM) approaches. This study employs the PRISMA method to conduct a systematic literature review, synthesizing published studies on risks within the corn supply chain as a raw material for poultry feed. Data sources include Scopus, ScienceDirect, Google Scholar, and Semantic Scholar. The initial dataset comprised 1,438 papers, which were filtered to include publications from 2015 to 2023. Using the PRISMA method, the selection process resulted in 124 final reports. The analysis suggests that sustainable SCRM approaches, such as the soft system dynamics methodology (SSDM), have significant potential for application in managing risks along the corn supply chain for poultry feed production.

1. Introduction

Agriculture is an industry closely tied to land and influenced by numerous factors that determine its success. Due to these conditions, it is highly susceptible to increased risks, which can significantly impact agricultural yields [1]. The agricultural supply chain is probabilistic, dynamic, and highly interdependent. These characteristics arise because agricultural products are perishable, the processes of planting, growing, and harvesting depend on the season, harvests vary in shape and size, and agricultural products possess handling challenges due to their unique characteristics. The high level of interdependence and complexity within the agricultural product supply chsain network makes it more vulnerable to disruptions. Supply chain disruptions can occur internally (within the relationship between a company's organization and its supplier network) or externally (between the supplier network and its environment) [2].

Corn is a significant agricultural product and is scientifically known as Zea mays L., serving as an essential source of nutrition for both humans and animals [3]. Additionally, corn is widely used as poultry feed. In Indonesia, feed production and the demand for livestock products are expected to continue increasing, which will consequently drive the growing demand for corn. This projection is based on the fact that poultry feed formulations typically consist of approximately 50% corn. Therefore, it is essential to control supply chain risks to prevent cascading consequences that may arise at any point within the supply network.

On the other hand, corn-producing countries are increasingly prioritizing the use of corn for biofuel production. Globally, this shift is reducing the availability of corn for animal feed, driving up its price and creating challenges for the livestock industry in Indonesia. Therefore, it is essential to find solutions to address this situation [3].

Uncertainty is a critical factor in determining an organization's value; higher uncertainty increases risk.

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This uncertainty often relates to supply and demand fluctuations at specific times [4]. Approaches that combine adaptation, mitigation, and opportunities for increased profitability can offer significant benefits to agriculture. Many stakeholders have expressed interest in further research to evaluate the effectiveness of management strategies across geographic regions and agroecosystems [5]. The dynamics of the fluctuating socio-economic environment present opportunities and challenges for companies worldwide, particularly those focused on supply chain performance. These companies must navigate uncertainty, complexity, and intense global competition. Risk management is crucial for supply chain performance, as supply chain risk management (SCRM) involves identifying and managing risks to improve relationships with customers and suppliers [6].

Risk is inevitable in the supply chain of perishable products, where frequent disruptions can significantly impact sustainability [7]. From a broader perspective, risk assessment supports planning, designing, and building economical, efficient, reliable, safe, secure, and sustainable supply chains. A systemic approach is essential, combining and evaluating considerations to identify optimal solutions for industries, investors, and authorities [8].

SCRM involves identifying and mitigating threats to supply chain performance. Strategically, it focuses on assessing and managing risks to reduce overall vulnerabilities [9]. However, modeling supply chain dynamics is challenging due to numerous variables. This complexity can be addressed by clearly defining the objectives and scope of the supply chain [10]. The main challenge in addressing problems in complex social systems is structuring the problem situation, capturing stakeholder mental models, and identifying system behaviors. Long-term policy interventions, such as the Soft System Dynamics Methodology (SSDM), model social and physical system complexities to resolve problematic situations [11].

Systems methodology integrates Systems Dynamics (SD) and Soft Systems Methodology (SSM) from the systems thinking paradigm. By combining stages of SD and SSM within the SSDM framework, systemic interventions can better address complex social problems. A comparative framework of SD, SSM, and SSDM highlights the synthetic and dialectical roles of SSDM in solving these issues [12].

This research aims to identify gaps in recent SCRM studies concerning corn as a poultry feed ingredient, using Bibliometric Analysis and PRISMA Method Analysis. The findings are expected to enhance risk mitigation strategies along the corn supply chain.

2. Material and method

Bibliometric analysis is a quantitative method used to review journal papers, books, or other types of publications [13]. Preferred Reporting Items for Systematic Reviews (PRISMA) is a framework used in systematic reviews to summarize and generate evidence regarding the design and application of agricultural policy evaluation methodologies [14]. It involves a systematic process of collecting relevant literature that meets pre-determined eligibility criteria to answer specific research questions.

The PRISMA model originates from healthcare studies, where it was developed to provide clinical practice guidelines and inform clinical decision-making through predefined methodological approaches and associated protocols. Its use is motivated by the need for a systematic and thorough research approach. The PRISMA method helps researchers summarize existing literature through a step-by-step process that is comprehensive, explicit, and transparent [15].

This research aims to conduct a literature review using VOSviewer for bibliometric analysis, followed by the PRISMA method. The time frame for the selected papers is from 2015 to 2023.

2.1. Literature data search

Four database sources were used to search for literature: Scopus, ScienceDirect, Google Scholar, and Semantic Scholar. A combination of related keywords, as shown in Table 1, was applied. Table 1 indicates that the total number of papers identified using these keywords is 1,483.

Table 1.
Recapitulation paper

Data base source	Keyword	Total
Scopus	"supply chain" AND "risk management AND "sustainability" "agriculture" AND "risk management" AND corn" "corn" AND "poultry feed" OR "sustainability risk management"	378 63 187
Scopus	"soft system dynamic methodology" AND "SSDM"	4
Science Direct	"supply chain" AND "risk management" "supply chain" AND "risk management" AND "sustainability" "agriculture" AND "risk management" "corn and poultry feed" AND "risk management" AND "sustainability"	38 128 79 268
Google Scholar	"supply chain AND risk management" corn and "poultry feed" AND " risk management" and "sustainability" soft AND system AND dynamic AND methodology AND "SSDM"	33 37 10
Semantic Scholar	supply chain AND "Sustainability" AND "risk management" AND Agriculture AND corn AND poultry soft system dynamic methodology AND "SSDM"	245 13
Total		1483

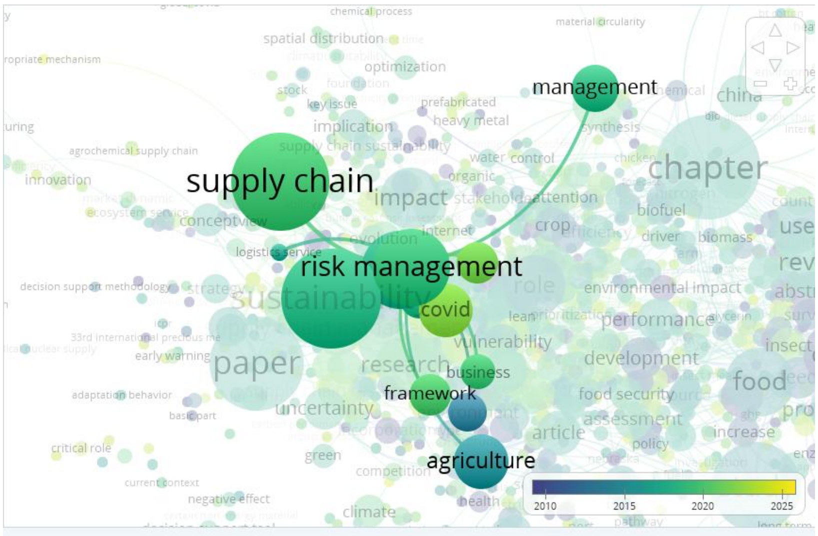

Figure 1. Visualization of supply chain networks, risk management, and agriculture

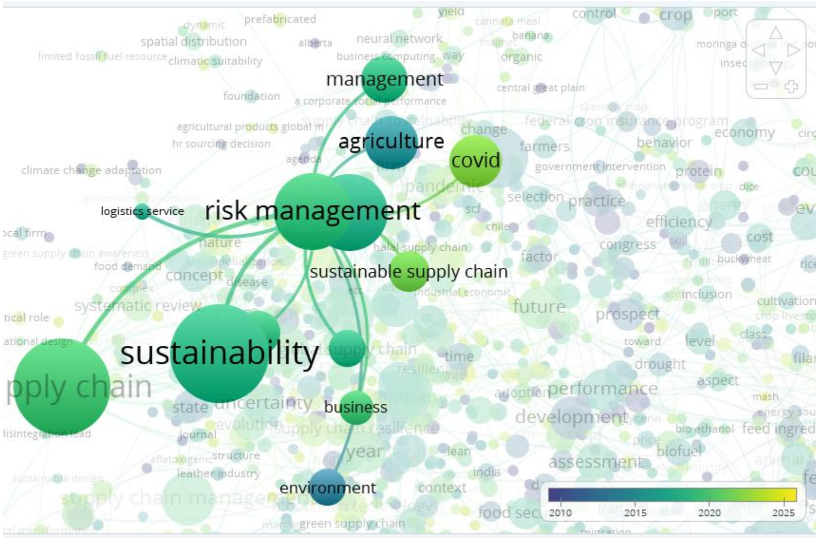

Figure 2. Visualization of agriculture, risk management, sustainability

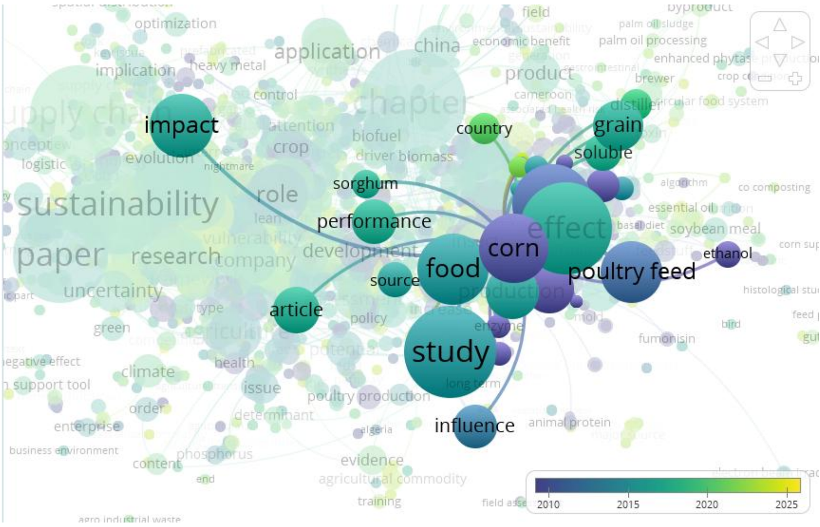

Figure 3. Visualization of Corn and Poultry Feed

2.2. *Bibliometric*

The next stage is the bibliometric stage using Vos Viewer, based on data from the initial screening of 1483 papers. The paper is submitted to the Vos Viewer to find out the initial mapping related to the potential novelty and feasibility of research by the existing problems, namely the relationship to the sustainable supply chain of corn as poultry feed. Each link can be identified using the exact network visualization, and potential new research gaps can be identified. Fig. 1 shows the keyword relationship between supply chain, risk management, and agriculture and is proven to have a direct relationship. Fig. 2 shows the keyword relationship between agriculture, risk management, and sustainability. In Fig. 3, the relationship between corn and poultry does not yet have a significant relationship.

2.3. PRISMA method

The PRISMA flow diagram image above shows the stages carried out, including:

- Identification stage: at this initial stage, the 1483 papers obtained were carried out in several identification steps, namely by eliminating papers that had duplicates because they were taken from several different database sources. After removing duplicates of 259 papers and identifying based on completeness, there were around 55 papers and 498 papers; the remaining papers that went through the identification stage were 671.
- Screening stage: at this stage, papers are filtered based on the relevance of keywords and related discussions; there are 227 unrelated papers. Four hundred forty-four papers are remaining. The remaining papers will continue by considering the Scopus index classification of the journal paper. 76 papers were not indexed by Scopus, which were then filtered again, and 244 papers were not included in journals indexed by Scopus 1, 2, and 3.
- The inclusion stage is the final stage, resulting in 124 papers: 64 papers indexed by Scopus 1, 44 papers indexed by Scopus 2, and 16 papers indexed by Scopus 3.

Fig. 4 shows the number of documents filtered by the PRISMA method over a period of 4 years.

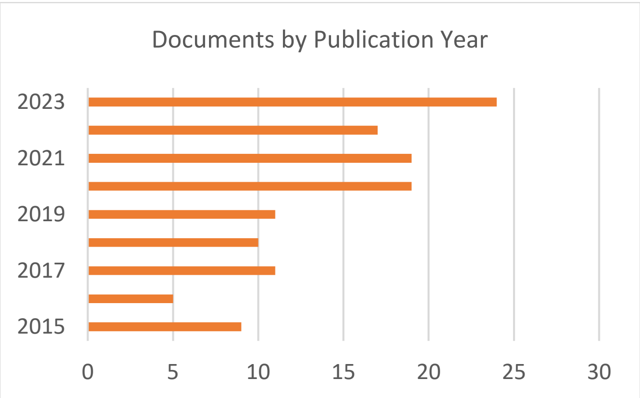

Figure 4. Document Classification

3. Results and discussions

Two analyses of the results will be discussed, namely, bibliometric analysis and analysis of the application of the PRISMA method.

3.1. Bibliometric analysis

Bibliometric stages can show network connections between the main research keywords. From a large network visualization, we can see each connection and identify possible research gaps, which can be considered novelty gaps. Fig. 1 and 2 show the relationship between supply chain, risk management, agriculture, and sustainability. In other words, some papers address topics related to these keywords.

Fig. 3 shows the relationship between the keywords "Corn" and "Poultry Feed," but they do not directly relate to the other main research keywords. Keywords that have no relationship in the network suggest that research gaps still exist, which could be addressed as novelty areas.

3.2. PRISMA analysis

This research aims to develop a supply chain model for poultry products using a System Dynamics (SD) approach by capturing the causal relationships between variables such as corn supply availability, feed mills, chicken production, and customer demand. The goal is to create scenarios where commodity demand can be adequately met, thereby strengthening food security. As the main ingredient in poultry feed, corn production can be increased through dense planting methods and the use of superior seeds. The availability of sustainable chicken feed will help boost poultry production and improve chicken farming methods. The proposed model can provide a better understanding of the poultry product food chain, which can then serve as input for relevant policymakers in formulating strategic programs to strengthen food security [16], [17], [18], [19], [20]. The results of the PRISMA method are shown in Appedices.

Regarding research papers with the keyword Soft System Dinamic Methodology, of the seven papers with the keyword system, they have yet to discuss topics related to corn as a raw material for poultry feed. Therefore, there is still a gap of novelty to be explored. The PRISMA method is a method that is integrated between quantitative and reference paper review methods. From the 3 PRISMA stages, namely identification, screening, and inclusion, 124 papers were obtained that can be used as a literacy source and support the novelty of research gaps.

4. Conclusions

This research aims to analyze the potential for a new study focusing on risk management along the supply chain of corn as a raw material for the poultry feed agro-industry. The literature used comes from four databases: Scopus, ScienceDirect, Google Scholar, and Semantic Scholar, using a combination of related keywords. From these four database sources, 1,483 papers were obtained. Bibliometric analysis was then conducted using VOSviewer to map the initial results. This stage revealed that many related keywords do not have direct relationships, highlighting potential gaps for future research topics.

The next stage involved using the PRISMA method, which helps filter the appropriate papers through the identification, screening, and inclusion stages. From this PRISMA process, the initial 1,483 papers were reduced to 123, filtered by the year range from 2015 to 2023. The papers indexed in Scopus were categorized into three groups. Based on relevant keywords, research on corn supply chain risk management as a sustainable poultry feed raw material using the Soft System Dynamics (SSDM) methodology was identified.

Declaration statement

Kulsum: **Conceptualization, Methodology, Software, Resources, Writing, Data curation, Validation**. Anas Miftah Fauzi: **Conceptualization, Methodology, Writing, Review, Supervision.** Supervision. Illah Saillah: **Conceptualization, Methodology, Writing, review, Supervision**. Ono Suparno: **Conceptualization, Methodology, Writing, review, Supervision**. Hoetomo Lembito: **Conceptualization, Methodology, Writing, Review, Supervision.**

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Disclosure statement

The authors report there are no competing interests to declare.

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Data availability statement

The data that support the findings of this study are available from the database system (Scopus, science direct, google scholar, semantic scholar), the corresponding author and the team, upon reasonable request.

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Appendices

Table A1.
Researh of agriculture

No	Author	Year
1	Bossman, A [16]	2023
2	Amaral, Antnio L [17]	2023
3	Adeyinka, Adewuyi Ayodele [18]	2022
4	Goyal, R [4]	2021
5	Rocchi L,Paolotti L,Cortina C,Fagioli FF,Boggia A [19]	2021
6	Carrer, M J [20]	2020
7	Onu-Okpara, I Q [21]	2019
8	Bachmair, S [22]	2018
9	Yorgey GG,Hall SA,Allen ER,Whitefield EM,Embertson NM,Jones VP,Saari BR,Rajagopalan K,Roesch-McNally GE,Van Horne B [5]	2017
10	Han, Eunjin [23]	2017
11	Mase, A S [24]	2017
12	Shimshoni JA,Barel S [25]	2017
13	Haigh, T [26]	2015

Table A2.
Researh of risk management

No	Author	Year
1	Vieira, A A C [27]	2023
2	Jamalnia, A [28]	2023
3	Mbah, Leslie T [29]	2023
4	Khan, Nasir Abbas [30]	2023
5	Hagen, I [31]	2023
6	Rinaldi M,Murino T,Gebennini E,Morea D,Bottani E [32]	2022
7	de Oliveira, U R [33]	2022
8	Wang L,Cheng Y,Wang Z [34]	2022
9	Valinejad, F [35]	2022
10	Nalluri, V [36]	2022
11	Zhou, Wang [37]	2021
12	SHANG, Yan [38]	2021
13	Eeswaran, R [39]	2021
14	da Silva, Cátia [40]	2020
15	Fagundes, M V C[41]	2020
16	Osorio Gómez, Juan Carlos [42]	2020
17	Deng, X [7]	2019
18	Yazdani M,Gonzalez ED,Chatterjee P [43]	2019
19	Liu, Lu [44]	2018
20	Markert, F [45]	2017
21	Multaharju, S [46]	2017
22	Zeng, Bingcong [47]	2017
23	Song, Wenyan [48]	2017
24	Anderson, C J [49]	2016
25	Mangla, Sachin Kumar [50]	2015
26	Venkatesh, V G [51]	2015
27	Freise, M [52]	2015

Table A3.
Researh of supply chain management

No	Author	Year
1	Carissimi, M C [53]	2023
2	Hong, L Jeff [54]	2023
3	Chukwuka OJ,Ren J,Wang J,Paraskevadakis D [9]	2023
4	Noorunnahar, Mst [55]	2023
5	Seuring, Stefan [56]	2022
6	Mishra D,Dwivedi YK,Rana NP,Hassini E [57]	2021
7	Fumagalli F,Ottoboni M,Pinotti L,Cheli F [58]	2021
8	Raza, J [59]	2021
9	Duong, N H [6]	2021
10	Hallikas, J [60]	2020
11	Cole, R [61]	2020
12	Xu, M [62]	2019
13	Duric, G [63]	2019
14	Ivanov, D [64]	2018
15	Ramezankhani, M J [65]	2018
16	Silvestre, Bruno S [66]	2018
17	Cuesta, V [67]	2017
18	Sulistio, Joko [68]	2015

Table A4.
Researh of sustainability

No	Author	Year
1	Chaudhuri, A [69]	2023
2	Adjei-Bamfo, P [70]	2023
3	Aman, S [71]	2023
4	Kähkönen, A.-K. [72]	2023
5	Masood, T [73]	2023
6	Alzate, I C [74]	2022
7	MartÃnez FD,Castorena EV,Uribe VV,Alvarado RE,SÃ¡enz EO,del Carmen GutiÃ©rrez Castorena M [75]	2021
8	Cole, R [76]	2020
9	Parish ES,Dale VH,English BC,Jackson SW,Tyler DD [77]	2016
10	Almeida, A [78]	2016
11	van Grinsven HJ,Erisman JW,de Vries W,Westhoek H [79]	2015

Table A5.
Researh of corn and poultry feed

No	Author	Year
1	Wossen, Tesfamicheal [80]	2023
2	UÃ§ak H,Yelgen E,ArÄ± Y [81]	2023
3	Hill, G [82]	2023
4	Mlambo, Victor [83]	2023
5	Akoto EY,Maier DE [84]	2023
6	Satterlee, T [85]	2023
7	Nacmcf [86]	2023
8	Yadav, S [87]	2022
9	Kim, E [88]	2022
10	Mousavi, S H [89]	2022
11	Ezugworie FN,Okeh OC,Onwosi CO [90]	2022
12	Adams, C B [91]	2022
13	Ortiz, D [92]	2022
14	Ito, K R [93]	2022
15	Abd El-Hack ME,El-Saadony MT,Shafi ME,Alshahrani OA,Saghir SA,Al-Wajeeh [94]	2022
16	Selaledi, L [95]	2021
17	Ibrahim, D [96]	2021
18	Nusairat, B [97]	2021
19	Cottrell JJ,Le HH,Artaiz O,Iqbal Y,Suleria HA,Ali A,Celi P,Dunshea FR [98]	2021
20	Torok VA,Luyckx K,Lapidge S [99]	2021
21	Olukomaiya, O O [100]	2021
22	Richardson, K E [101]	2021
23	Chakraborty, Debolina [102]	2021

No	Author	Year
24	Caldas, J V [103]	2020
25	Olson, E [104]	2020
26	Gherbawy, Y A [105]	2020
27	Alyileili, S R [106]	2020
28	Emami, N K [107]	2020
29	Khalil, M M [108]	2020
30	Haberecht, S [109]	2020
31	Guo, S [110]	2020
32	Dabbou, S [111]	2020
33	Suwignyo, B [112]	2020
34	De Cesare, Alessandra [113]	2019
35	Fries-Craft, K [114]	2019
36	Teixeira Netto, M V [115]	2019
37	Metayer, J.-P.[116]	2019
38	Upadhyaya, I [117]	2019
39	Hosseini, N G [118]	2019
40	Al Khalaileh, N I [119]	2018
41	Borsatti, L [120]	2018
42	Khan, I [121]	2017
43	Seman-Varner R,Varco JJ,O'Rourke ME [122]	2017
44	Sultana, F [123]	2016
45	Iqbal, S Z [124]	2016
46	Alvarenga, R R [125]	2015
47	Abd El-Hack, M E [126]	2015

Table A6.
Researh of Soft System Dinamic Methodology

No	Author	Year	Topic
1	Hosseinzadeh, Mahnaz [127]	2023	petroleum industry
2	Susanto H,Indrawan D [128]	2022	Palm
3	Andayani SA,Sumekar Y,Sukmawani R,Ismail AY,Nugraha R,Umyati S [129]	2021	Red Chili Farmers
4	Hosseinzadeh, Mahnaz [11]	2020	oil industry
5	Zolfagharian M,Romme AG,Walrave B [130]	2018	Healthcare
6	Zheng, Yan-Zhe [131]	2018	Goverment
7	Hanafizadeh P,Mehrabioun M [132]	2018	SSM