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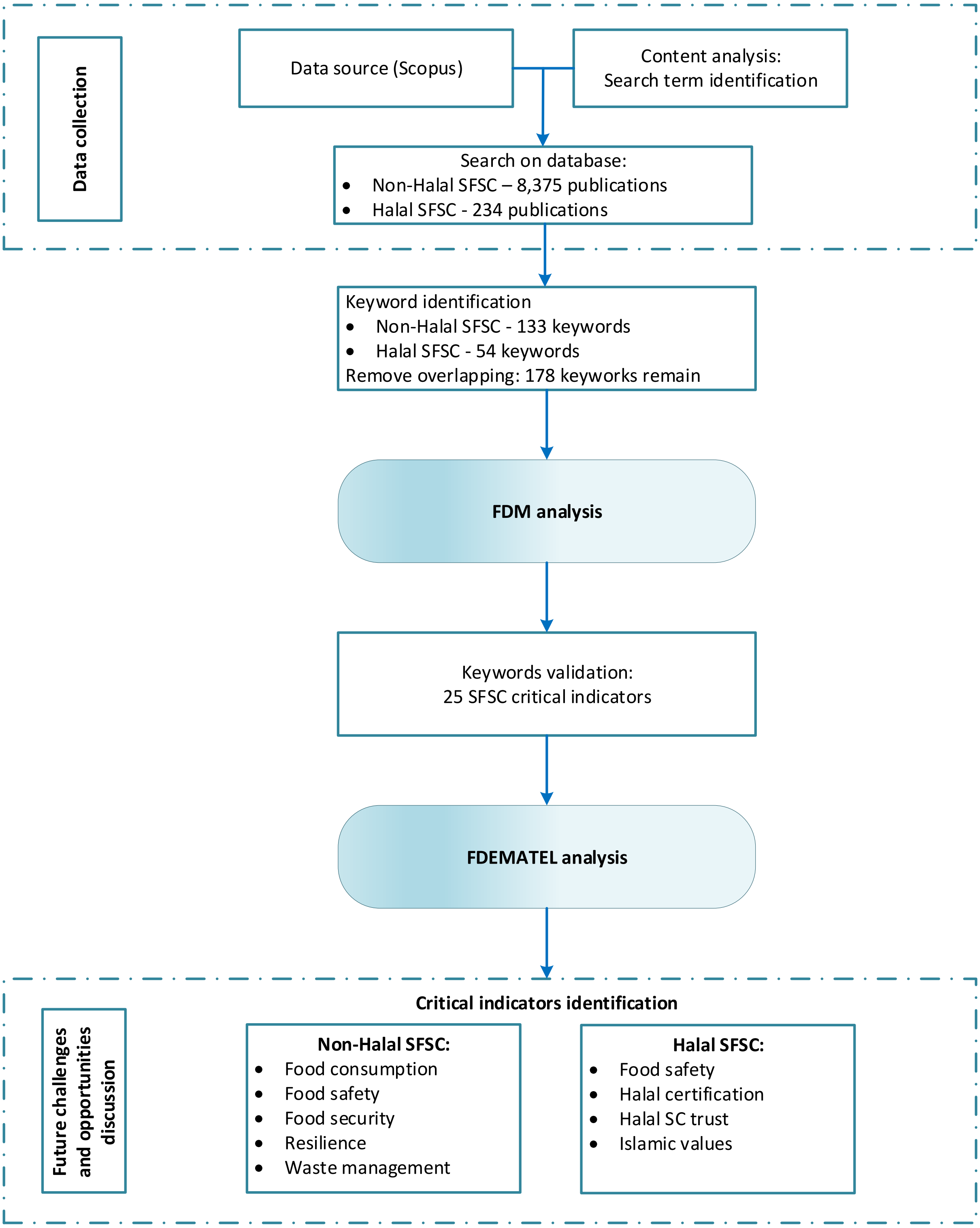
Data-driven on sustainable food supply chain: A comparison on Halal and non-Halal food system

Abstract

This study contributes a data-driven of sustainable food supply chain with the comparison between Halal and non-Halal food, and suggestion for future studies and practical fulfillments. Although food supply chain is urged to become sustainable, there is a lack of a systematic data-driven describing the most appropriate indicators to advance both Halal and non-Halal sustainable food supply chain. With an aim of comparing and analyzing up-to-date sustainable food supply chain, a combination of content analysis, fuzzy Delphi method, fuzzy decision-making trial and evaluation laboratory are presented. The results show that the most significant indicators for non-Halal sustainable food supply chain are food consumption, food safety, food security, resilience, food waste management. The most crucial indicators of Halal sustainable food supply chain consist of Halal certification, Halal supply chain trust, Islamic values, Halal food safety. A contemporary sustainable food supply chain is presented and future trends, challenges and opportunities are determined.

Keywords: sustainable food supply chain; Halal; data-driven; content analysis; fuzzy decision-making trial and evaluation laboratory



Graphical abstract

Table of Contents

1. Introduction

In contemporary years, food industry has significantly transformed as the increased population provoke more complicated market demand on the quality, safety and integrity of food, from which causes pressure on each phase of food supply chain (FSC) (Ali and Suleiman, 2018; Manteghi et al., 2021). Sustainable food supply chain (SFSC) emerges as an appropriate response to such challenges and is characterized as management of supply chain (SC) activities, funds, data, resources in the food industry with main target on sustainable development goals (Tseng et al., 2020; Krishnan et al., 2020). Regarding SFSC, besides economic goals such as rising revenue or extending profits, environmental together with social goals are become imperative. While social objectives emphasize food safety and quality assurance to protect consumer health, environmental side of SFSC highlights the importance of decreasing energy consumption and food waste by balancing the product conservation time, promoting capability of food traceability, and providing good quality packaging (Wang and Yue, 2017; Lemaire and Limbourg, 2019). Yet, goals of sustainability are sometimes in conflict with each other, and few efforts have been made to systematically evaluate the complicated of SFSC as well. Therefore, indicating the way to efficiently handle FSC with a sustainable way based on deciding the important indicators related to these goals is needed (Wu and Huang, 2018; Manteghi et al., 2021).

In practices, there are two prominent niches of SFSC referring to non-Halal and Halal food system. Accounting for 20% of food industry worldwide, Halal food is expected to increase to higher than 70% by 2050 with the drastic growth of Halal food demand in both non-Muslim and Muslim market (Hosain, 2021). Halal SFSC is deemed as a specific process among conventional SFSC, which aims to maintain food safety, quality, and integrity from original source to the final consuming point following Halal perspectives (Ali et al., 2021). Consequently, besides the common problems in the non-Halal SFSC, the halal SFSC also has its own challenges like Halal counterfeiting, cross-infection, Halal deception, no global standardized Halal certification, and difficulty in controlling the authenticity and traceability system. Although assurance system has been built to ensure the halal standards on production traceability, there is still confusion amongst what is actually means and how to ensure the integrity of these two distinct FSC system in the global market. This puts pressure on exploring specific indicators of these two SFSCs for practical application.

The indicators for SFSC and Halal SFSC have been explored separately in the literature (Wu and Huang, 2018; Jouzdani and Govindan, 2021; Rejeb et al., 2021). Nonetheless, a systematic data-driven on the current studies which describes the most appropriate indicators to advance both SFSC and Halal SFSC is still lacking. In addition, a holistic comparison of these two supply networks based on one common set of indicators is also essential to define the best practical solutions for each SC. In consequence, this study is implemented with two main objectives including:

- To analyze the state-of-the-art and define one common set of indicators for both SFSC and Halal SFSC;
- To figure out the most fundamental indicators for each SC in order to determine trends and implications for further studies;

The research questions are as follows:

(1) What are the common set of indicators for both SFSC and Halal SFSC?

(2) What are the most critical indicators for SFSC and Halal SFSC in order to determine trends and implications?

This study suggests a hybrid method, in which content analysis is applied to find out proper information to pinpoint crucial topics accompanied by non-automatic or semi-automatic ways (Bui et al., 2021). These methods are utilized in order to determine the SFSC and Halal SFSC indicators founded on the Scopus database employing the VOSviewer software. Then, fuzzy Delphi method (FDM) has been exploited to evaluate indispensable indicators transformed from experts' linguistic assessment (Tseng et al., 2020). Fuzzy decision-making trial and evaluation laboratory (FDEMATEL) has been engaged to diagnose crucial attributes for further studies (Tseng et al., 2021).

Contributions of the study include (1) suggesting favorable flows for studies in the future by comparing the status of non-Halal SFSC and Halal SFSC and pointing out critical indicators; and (2) recommending needed issues for further investigations in both academic and practical areas.

This study is divided into 6 sections. Section 1 introduces the general knowledge of non-Halal SFSC, Halal SFSC, objectives, recommended methods and contributions. The literature review regarding non-Halal SFSC, Halal SFSC is presented in section 2. Section 3 gives clearly explanation about methods adopting in this study and proposes analysis steps. The results and findings are presented in section 4, while discussion on critical discussion on challenges and opportunities for future studies are distributed in section 5. Section 6 concludes all imperative information and summaries the future trends.

2. Literature review

2.1. Non-Halal sustainable food supply chain

For the Non-Halal SFSC, known as general FSC system, the main purposes of any SFSC are to ensure food quality together with safety for preventing the hazard of food poisoning outbreaks and protect consumer health through delivering food and remain the freshness from the sources to demand zones (Musavi and Bozorgi-Amiri, 2017). However, in the environmental side, as low temperature is needed to storage, handle and then guarantee the quality of foods in distributing process, it undoubtedly leads to higher consuming of energy together with diverse transportation mode from the traditional SCs (Jouzdani and Govindan, 2021). Besides, food waste which is mainly resulted from overproduction compared to actual market demand is also listed to be among the most substantial threats to SFSC. The increase of waste is recognized as leading to exhaustion of resources and negative environmental impacts.

The literature has measures the non-Halal SFSC such as preventing resource consumption and food waste, balancing the product conservation time, promoting capability of food traceability, and providing good quality packaging (Lemaire and Limbourg, 2019). Long and Liao (2021) proposed a social participatory allocation network combined with partial relations of alternatives for SFSC selection. Ekren et al. (2021) examined lateral-inventory share models to handle a SFSC in an internet of things (IoT) environment. Strube et al. (2021) explored the suggestions relating to data-driven private-ordering for the circulation of responsibility as well as power in a FSC to support sustainability claims. Yet, the management of FSC is more complicated than other SCs due to liability to be perishable, long producing time, seasonal production along with consumption, changeability regarding product quality as well as harvest.

2.2. Halal sustainable food supply chain

Halal SFSC is deemed as the managing procedure of Halal food from various supply sources to end-users, with the participation of multiple stakeholders, who may also handle non-Halal food to satisfy both Halal and non-Halal customers' requirements. Dubai Islamic Economy Development Centre has reported the Halal industry as a global high-speed-developing market valued at trillion dollars. In practice, the amount of food consumed by Muslim consumers is assessed to be worth about $1.3 trillion per year, and this figure is predicted to approach $1.9 trillion in 2023 (Rejeb et al., 2021). In Halal SFSC, the major objective is more than pleasing the customer, but also to remain the food's integrity and safety throughout the whole SC process. Wu and Huang (2018) stated that as one critical dimension of SFSC, food safety involves essential regulations to guarantee quality throughout the SC; thus, halal standards are required to be established and applied. Accordingly, a halal assurance system is built, which demands product traceability from firms to control every possible derivation of contamination throughout supply networks, including specific information from suppliers. Tan et al. (2017) argued that this system enables a firm to produce higher-quality and more responsive products to customers, reduce manufacturing costs, and attain supplier sustainability.

Many studies on Halal SFSC were carried out in contemporary years. Ali et al. (2021) suggested a sustainable framework relating to Halal food small and medium enterprise's blockchain dilemmas comprising complication and capability, expense and competitive advantage, management of changes and outside burdens, sustainable production, and regulatory accountability. Rejeb et al. (2021) reviewed internet of things studies within Halal FSC context as a fundamental element to safeguard the food Halalness. Kohilavani et al. (2021) developed a safe Halal food management system integrating Islamic dietary standards to food safety, remarkably with relevance to current needs for practicability urged by food manufacturers. Despite an increase in academic publications, prior studies might point out the indicators can be breached to approach the SFCS but not fully address the critical operational handling indicators of which the Halal SFSC is involved to achieve a successful sustainable performance.

3. Method

Analysis phases are suggested, collection of data, content analysis, FDM, FDEMATEL are specifically explained in this section.

3.1. Recommended analysis phases

A data-driven analysis through content analysis, FDM, FDEMATEL are used to explore SFSC with a comparison on Halal and non-Halal food. Lively diagrams together with data congeniality are created by employing VOSviewer. In this study, 30 experts were selected from academic together with practitioners possessing no less than 10 years' experience in SFSC and HSFSC (shown in Appendix A).

The analysis phases were suggested.

1. With an aim of collecting information from Scopus database, proper searching terms are chosen for applying deductive coding.
2. Content analysis is performed via making use of VOSviewer for categorizing SFSC with a comparison on Halal and non-Halal food literature structure. The keywords are combined and removed all the overlapping ones as the input for the FDM evaluation
3. By applying FDM, irrational indicators are removed thanks to opinions of experts via questionnaire.
4. By utilizing FDEMATEL, critical indicators are determined for both Halal and non-Halal SFSC

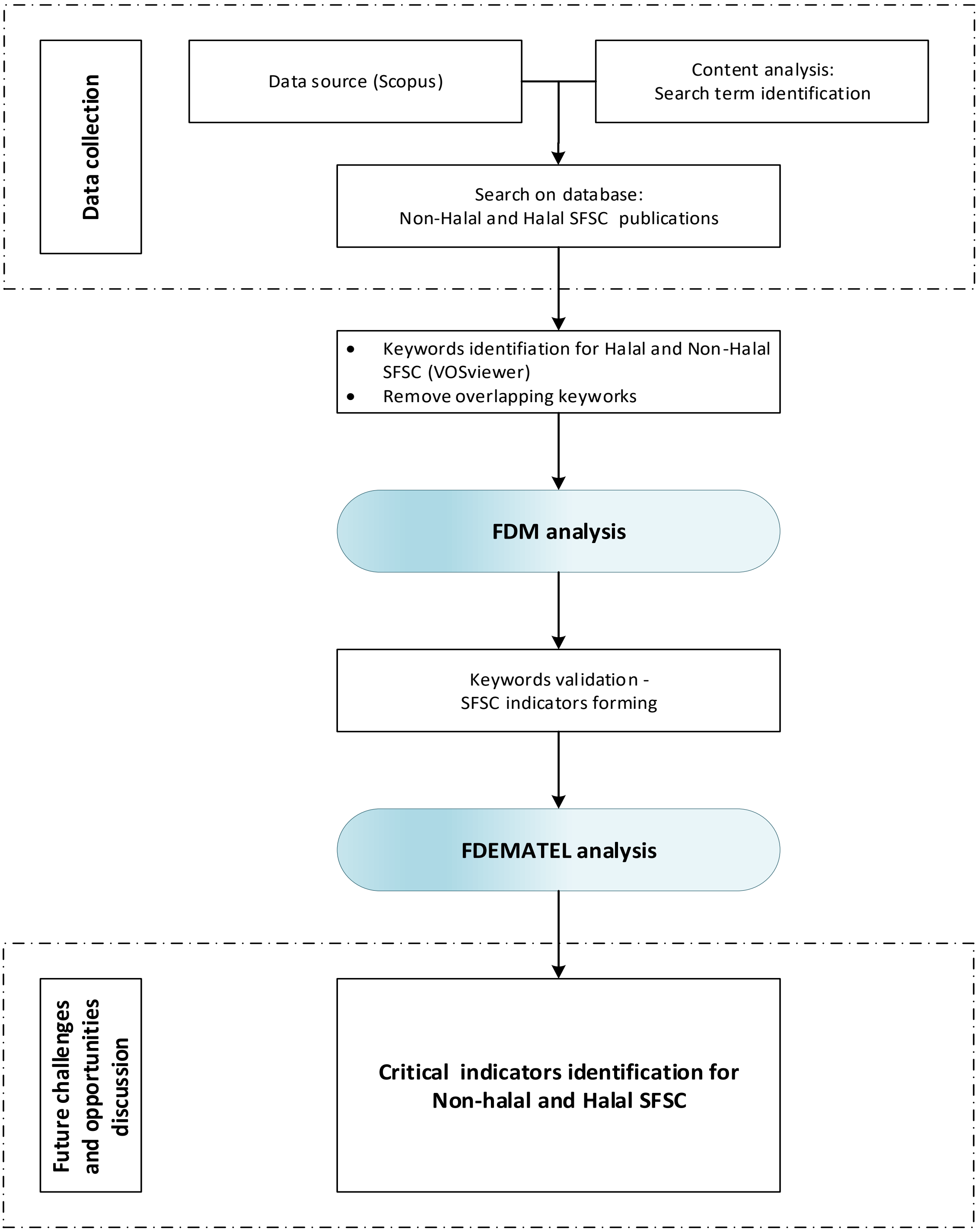


Figure 1. Recommended analysis steps

3.2. Content analysis

In an attempt to depict comprehensive and thorough analysis of the contemporary knowledge concerning SFSC with a comparison on Halal and non-Halal food, content analysis is employed in this study. Utilizing this analysis, the essences of full-text articles are completely described and an implicit framework for main articles is developed by shrinking immense texts' along with words' amounts into predetermined classes. Two kinds of coding encompass inductive coding as well as deductive coding in recent application of content analysis with difference in the way classifications attained. Inductive coding determines codes through a process while deductive coding predetermines them before inspecting the content (Bui et al., 2021). The deductive method is first employed in this study for predetermined search terms in order to find SFSC literature from the database.

The Scopus database is used owing to the encompassment of a wider-ranging data than others (Tsai et al., 2020). The compiled data contain numerous identifiers like title, abstract, citation archive, author, author affiliation, author keywords, nation, publication time. The Scopus data is relevant to evaluate the knowledge of the SFSC literature with a comparison on Halal and non-Halal food. This study adopts the search boundary restricted before March 3rd, 2021 and narrowed to English-language reviews together with articles. The searching terms employed were ("sustain*") AND ("food") AND ("supply" OR "suppli*" OR "demand*") AND ("chain*" OR "network*" OR "system*" OR "value chain") for non- Halal SFSC; and ("food") AND ("supply" OR "suppli*" OR "demand*") AND ("chain*" OR "network*" OR "system*" OR "value chain") AND ("Halal" OR "Islam*" OR "Muslim*") for Halal SFSC.

VOSviewer version 1.6.11 is used in this study for investigating the SFSC - a comparison on Halal and non-Halal food literature structure, thus indicating knowledge gaps as future study trends.

3.3. Fuzzy Delphi Method

Treatment of the fuzziness in assessments from experts with the benefit of diminishing interviews' numbers and inspection time while presenting more thorough expert expressions are facilitated by FDM (Tsai et al., 2020). In this study, linguistic terms are employed to present experts' expressions which must be changed into equivalent triangular fuzzy numbers for FDM and FDEMATEL process, as exhibited in Table 1.

Table 1. Transformation table of linguistic terms

Scale	Linguistic terms	Corresponding triangular fuzzy numbers (FDM process)	Corresponding triangular fuzzy numbers (FDEMATEL process)
5	Very high importance	(0.75, 1.0, 1.0)	(0.7, 0.9, 1.0)
4	High importance	(0.5, 0.75, 1.0)	(0.5, 0.7, 0.9)
3	Strong	(0.25, 0.5, 0.75)	(0.3, 0.5, 0.7)
2	Low importance	(0.0, 0.25, 0.5)	(0.1, 0.3, 0.5)
1	Very low importance	(0.0, 0.0, 0.25)	(0.0, 0.1, 0.3)

Significance value regarding indicator e is assessed by expert f as $j_{ef} = \left(n_{ef}; o_{ef}; p_{ef}\right)$, in which:

$e = 1,2,3, \dots, n;$

$f = 1,2,3, \dots, m;$

n, o, p: triangular fuzzy numbers adopted from linguistic scale

n_{ef}, o_{ef}, p_{ef}: triangular fuzzy numbers of indicator e is assessed by expert f

Then, weight j_e of indicator e is $j_e = (n_e; o_e; p_e)$, where:

$n_e = min\left(n_{ef}\right);$

$o_e = \left(\prod_1^m o_{ef}\right)^{1/m}$; (m: the number of experts)

$p_e = max(p_{ef})$,

The convex combination value S_x is gained via the following equation:

$$S_e = \int(l_e, u_e) = \varepsilon[l_e + (1-\varepsilon)u_e] \quad (1)$$

In which:

$$l_e = p_e - \gamma(p_e - o_e) \quad (2)$$

$$u_e = n_e - \gamma(o_e - n_e) \quad (3)$$

ε is employed to direct optimism level of decision-makers and to attain equalized judgments among experts. The scope of γ is commonly between 0 and 1 for showing experts' judgments which are positive or negative. This value is normally assigned in 0.5 as the common circumstance.

Eventually, the following equations are utilized to compute the threshold for eliminating worthless attributes.

$$\mu = \sum_{x=1}^{n}(S_e/n) \text{ (n: the number of indicators)} \quad (4)$$

If $S_e \geq \sigma$, attribute x is accepted; or else, the attribute needs to be screened out.

3.4. Fuzzy decision-making trial and evaluation laboratory (FDEMATEL)

FDEMATEL integrated DEMATEL and fuzzy set theory for transferring experts' assessments into visual form for investigation (Bui et al., 2021). The computation processes are presented as below.

The linguistic scales as shown in Table 1 are adopted for evaluations. Supposing there are a numbers of expert in the assessment panel, then they are asked to compare the interrelations between b^{th} indicator and c^{th} indicator, which can be written as E_{bc}^{a}. Nevertheless, these linguistic scales need to be converted into corresponding triangular fuzzy number as $\left(e_{\ell}{}_{bc}^{a}, e_{m}{}_{bc}^{a}, e_{r}{}_{bc}^{a}\right)$ by referring to Table 1.

Normalizing procedure

$$\bar{E}_{bc}^{a} = \left(\bar{e}_{\ell}{}_{bc}^{a}, \bar{e}_{m}{}_{bc}^{a}, \bar{e}_{r}{}_{bc}^{a}\right) = \left[\frac{(\bar{e}_{\ell}{}_{bc}^{a} - min\, \bar{e}_{\ell}{}_{bc}^{a})}{\tau}, \frac{(\bar{e}_{m}{}_{bc}^{a} - min\, \bar{e}_{m}{}_{bc}^{a})}{\tau}, \frac{(\bar{e}_{r}{}_{bc}^{a} - min\, \bar{e}_{r}{}_{bc}^{a})}{\tau}\right] \quad (5)$$

where $\tau = max\, \bar{e}_{r}{}_{bc}^{a} - min\, \bar{e}_{\ell}{}_{bc}^{a}$

Gaining the left $(\mathrm{L}_{\mathrm{bc}}^{\mathrm{a}})$ and right $(\mathrm{R}_{\mathrm{bc}}^{\mathrm{a}})$ normalized value

$$(L_{bc}^{a}, R_{bc}^{a}) = \left[\frac{\bar{e}_{m}{}_{bc}^{a}}{(1+\bar{e}_{m}{}_{bc}^{a} - \bar{e}_{\ell}{}_{bc}^{a})}, \frac{\bar{e}_{r}{}_{bc}^{a}}{(1+\bar{e}_{r}{}_{bc}^{a} - \bar{e}_{m}{}_{bc}^{a})}\right] \quad (6)$$

Calculating the crisp values $(\mathrm{CP}_{\mathrm{bc}}^{\mathrm{a}})$

$$CP_{bc}^{a} = \frac{[L_{bc}^{a}(1-L_{bc}^{a}) + (R_{bc}^{a}) \times (R_{bc}^{a})]}{(1 - L_{bc}^{a} + R_{bc}^{a})} \quad (7)$$

Prior to arranging the crisp values into direct relation matrix $[DR]$, accumulating all experts' crisp values is needed by applying following equations.

$$dr_{bc} = \frac{\sum_{a=1}^{f} CP_{bc}^{a}}{a}, b, c = 1,2, d \quad (8)$$

$$[DR] = [dr_{bc}]_{d\times d} \quad (9)$$

Following equations are employed for normalizing the direct relation matrix $[\overline{DR}]$.

$$[\overline{DR}] = \left[\frac{dr_{bc}}{\max\limits_{1\leq b\leq d} \sum_{c=1}^{d} dr_{bc}}\right]_{d\times d} \quad (10)$$

The total relations matrix $[TR]$ is obtained by counting on the following equations.

$$[TR] = [\overline{DR}] \times \{\mathrm{I} - [\overline{DR}]\}^{-1} \quad (11)$$

Thereinto, $[TR]$ can be expressed as $[tr_{bc}]_{d\times d}$.

From the total relation matrix, using equations as below to attain driving power (α) and dependence power (β).

$$\alpha_i = \sum_{b=1}^{d} [tr_{bc}]_{d\times d} = [tr_b]_{d\times 1} \quad (12)$$
$$\beta_j = \sum_{c=1}^{d} [tr_{bc}]_{d\times d} = [tr_c]_{1\times d} \quad (13)$$

Attributes need to be mapped into cause-and-effect diagrams founded on the coordinates $[(\alpha_i + \beta_j), (\alpha_i - \beta_j)]$. $(\alpha_i + \beta_j)$ stands for attributes' importance level, with a higher value depicting a more critical attribute. $(\alpha_i - \beta_j)$ classifies attributes into cause-and-effect groups by employing $(\alpha_i - \beta_j) > 0$ and $(\alpha_i - \beta_j) < 0$, correspondingly.

4. Results

This part illustrates the findings from content analysis, along with FDM analysis and FDEMATEL analysis.

4.1. Step 1 and 2 - Content analysis results

4.1.1. Non-Halal SFSC

In the data collection process, 8,375 publications with 15,418 keywords were analyzed to point out the vital indicators for non-Halal SFSC.

Table 2 presents the result from VOSviewer process, in which 133 keywords are defined with at least 15 times of occurrence. Based on the occurrence weight, the indicators such as sustainability, food security, climate change, agriculture, food waste have the higher appearance level in recent studies; whereas depending on the average published year score in Table 2, the later indicators include blockchain, circular economy, food consumption, transformation and waste management. From the result, topics related to these indicators are all demanded in recent years, including those that are examined quite a lot and others that are just begun to be approached.

Table 2. Co-occurrence of author keywords for non-Halal sustainable food supply chain

ID	Keyword	Occurrence	Average published year
1	adaptation	41	2017
2	agribusiness	21	2016.048
3	agricultural sustainability	15	2017.467
4	agriculture	186	2016.882
5	agroecology	42	2016.262
6	alternative food networks	30	2017.933
7	anaerobic digestion	28	2016.357
8	animal welfare	19	2015.158
9	aquaculture	81	2016.432
10	beef	17	2015.471
11	biochar	15	2018.333
12	biodiesel	24	2015.833
13	biodiversity	61	2016.197
14	bioeconomy	28	2018.607
15	bioenergy	74	2015.743
16	biofuel	29	2015.103
17	biogas	21	2016.571
18	biomass	50	2016.96
19	biorefinery	34	2016.088
20	blockchain	18	2020.111

21	carbon footprint	50	2016.98
22	circular economy	79	2019.532
23	climate change	226	2016.974
24	conservation	23	2016.435
25	consumption	25	2016.88
26	corporate social responsibility	22	2017.227
27	covid-19	36	2020.417
28	crop rotation	15	2015.067
29	crop yield	19	2016.526
30	cropping systems	19	2015.947
31	dairy	19	2017.579
32	demand	15	2015.933
33	diet	25	2017.08
34	drought	18	2016.667
35	economics	19	2016.474
36	ecosystem services	102	2016.402
37	education	16	2017.125
38	energy efficiency	21	2016.429
39	environmental sustainability	46	2017.326
40	evapotranspiration	16	2016.875
41	farmers	16	2017.938
42	feed	15	2016.533
43	fish	21	2015.619
44	fisheries	19	2015.158
45	food consumption	17	2018.941
46	food loss	25	2018.12
47	food policy	28	2017.536
48	food processing	22	2017.091
49	food production	49	2016.98
50	food safety	62	2016.677
51	food security	486	2016.817
52	food sovereignty	16	2016.688
53	food supply chain	119	2017.664
54	food sustainability	19	2017.579
55	food systems	89	2017.764
56	food waste	155	2017.987
57	food-energy-water nexus	16	2018.25
58	governance	43	2016.721
59	greenhouse gas emissions	48	2017.292
60	groundwater	23	2016.652
61	health	46	2017.413
62	industrial ecology	28	2017.893
63	innovation	54	2016.87
64	irrigation	65	2015.923
65	land use	79	2016.76

66	life cycle assessment	148	2017.615
67	livelihoods	22	2016.909
68	livestock	56	2015.518
69	local food systems	26	2017.423
70	logistics	27	2017.037
71	maize	20	2016.35
72	microalgae	31	2017.871
73	mitigation	22	2016.136
74	natural resources	17	2015.353
75	nitrogen	34	2016.588
76	nutrition	90	2017.489
77	obesity	15	2016.533
78	optimization	27	2017.556
79	organic food	23	2016.348
80	packaging	26	2016.462
81	pesticides	15	2015.533
82	phosphorus	42	2016.857
83	policy	49	2016.98
84	precision agriculture	19	2017.105
85	production	15	2016.333
86	protein	16	2017.375
87	public health	17	2017.235
88	quality	19	2015.421
89	remote sensing	33	2018
90	renewable energy	40	2017.375
91	resilience	76	2017.342
92	retail	15	2015.333
93	rice	32	2016.375
94	rural development	23	2017.609
95	seafood	22	2016.682
96	short food supply chains	29	2017.586
97	social-ecological systems	15	2017.667
98	solar energy	18	2017.778
99	sub-saharan africa	26	2016.231
100	supply chains	32	2016.719
101	sustainability	787	2017.055
102	sustainable agriculture	135	2016.807
103	sustainable consumption	21	2016.476
104	sustainable diets	33	2018.091
105	sustainable food	24	2016.583
106	sustainable food systems	25	2017.72
107	sustainable intensification	73	2017.192
108	sustainable production	18	2016.944
109	system dynamics	35	2018
110	technology	16	2017.938

111	traceability	33	2017.303
112	trade	27	2016.852
113	trade-offs	22	2017.546
114	transformation	15	2018.867
115	uncertainty	22	2017.046
116	urban agriculture	54	2017.222
117	urban farming	15	2017.8
118	urban metabolism	15	2016.467
119	urbanization	18	2017.111
120	vegetables	15	2016.4
121	virtual water	26	2016.039
122	vulnerability	22	2016.864
123	waste management	19	2018.158
124	water footprint	55	2016.946
125	water productivity	18	2016
126	water quality	16	2016.125
127	water resources	26	2015.846
128	water scarcity	33	2016.939
129	water security	17	2017.647
130	water use efficiency	20	2017.2
131	water-energy-food nexus	26	2018.615
132	wheat	22	2015.955
133	yield	21	2016.857

4.1.2. Halal SFSC

The same data collection process is applied for publications relating to Halal SFSC, from which 234 publications with 652 keywords were examined to indicate the critical indicators.

Table 3 exhibits the result from VOSviewer, in which 54 keywords are identified with at least 2 times of appearance. Referring to the occurrence weight index, the keywords include Halal food, SC, Halal certification, and food integrity have higher frequency of occurrence in studies; whereas based on the average published year in Table 3, the keywords like migration, SC risk, meat industry, blockchain, Halal market, and downstream occur more often lately.

Table 3. Co-occurrence of author keywords for Halal sustainable food supply chain

ID	Keyword	Occurrence	Average published year
1	agriculture	2	2016.5
2	animal feed	2	2018
3	animal welfare	2	2009.5
4	blockchain	4	2019.75
5	downstream	2	2020
6	environmental management system	3	2017.667
7	food industry	7	2018
8	food integrity	4	2017
9	food manufacturer	2	2018.5
10	food safety	3	2019
11	food security	4	2017.5

12	food supply chain	8	2018.125
13	food supply chain integrity	2	2017
14	Halal awareness	2	2019
15	Halal certification	16	2018.25
16	Halal certification and labelling	2	2019.5
17	Halal food	26	2017.269
18	Halal food industries	2	2013
19	Halal food supply chain	8	2018
20	Halal industry	4	2016.5
21	Halal inspection	2	2017.5
22	Halal integrity	7	2018.857
23	Halal logistics	9	2015.778
24	Halal market	3	2019.667
25	Halal meat	2	2018.5
26	Halal portal	2	2019.5
27	Halal practices integrity	2	2018.5
28	Halal product	2	2018
29	Halal supply chain performance	2	2019.5
30	Halal supply chain trust	2	2018.5
31	Horeca	2	2013.5
32	Indonesia	2	2016.5
33	integrity	2	2018.5
34	Islamic manufacturing practices	3	2017.667
35	Islamic values	2	2018
36	Kosher	3	2018
37	lean manufacturing	3	2017.667
38	lean practices	2	2013.5
39	legislation	2	2011.5
40	meat	2	2020
41	meat industry	2	2020
42	migration	2	2020.5
43	Muslim	3	2018.333
44	perception	2	2019
45	purchase intention	2	2016.5
46	risks	2	2018
47	supplier management	2	2017.5
48	supply chain	17	2015.882
49	supply chain integration	4	2016.5
50	supply chain management	8	2017.25
51	supply chain performance	2	2019.5
52	supply chain risk	3	2020
53	total quality management	3	2017.667
54	traceability	4	2016

4.2. Step 3 - FDM results

From the result of content analysis, by combining the removed all overlapping keywords from the Halal and non-Halal SFSC literature, this study proposes a set of 178 keywords for both type of SFSC. The first round of FDM evaluation process based on experts' judgements is illustrated through Table 4 using equation (1)-(4). From the first round, 78 indicators are remained with the value over the threshold of 0.663.

Table 4. FDM screening out for indicators (round 1)

Indicators	l	u	S	Decision
adaptation	0.500	0.876	0.792	Accepted
agribusiness	0.000	0.000	0.333	Unaccepted
agricultural sustainability	0.000	0.775	0.592	Unaccepted
agriculture	0.500	0.767	0.756	Accepted
agroecology	0.500	0.819	0.773	Accepted
alternative food networks	0.500	0.767	0.756	Accepted
anaerobic digestion	0.000	0.836	0.612	Unaccepted
animal welfare	0.000	0.783	0.594	Unaccepted
aquaculture	0.000	0.664	0.555	Unaccepted
beef	0.500	0.767	0.756	Accepted
biochar	0.000	0.680	0.560	Unaccepted
biodiesel	0.000	0.783	0.594	Unaccepted
biodiversity	0.000	0.828	0.609	Unaccepted
bioeconomy	0.500	0.789	0.763	Accepted
bioenergy	0.000	0.762	0.587	Unaccepted
biofuel	0.500	0.812	0.771	Accepted
biogas	0.000	0.783	0.594	Unaccepted
biomass	0.000	0.755	0.585	Unaccepted
biorefinery	0.500	0.781	0.760	Accepted
blockchain	0.000	0.813	0.604	Unaccepted
carbon footprint	0.500	0.819	0.773	Accepted
circular economy	0.500	0.819	0.773	Accepted
climate change	0.500	0.819	0.773	Accepted
conservation	0.500	0.827	0.776	Accepted
consumption	0.000	0.836	0.612	Unaccepted
corporate social responsibility	0.250	0.732	0.661	Unaccepted
covid-19	0.250	0.741	0.664	Accepted
crop rotation	0.000	0.813	0.604	Unaccepted
crop yield	0.000	0.790	0.597	Unaccepted
cropping systems	0.000	0.790	0.597	Unaccepted
dairy	0.000	0.768	0.589	Unaccepted
demand	0.000	0.833	0.611	Unaccepted
diet	0.000	0.000	0.333	Unaccepted
drought	0.000	0.844	0.615	Unaccepted
economics	0.000	0.775	0.592	Unaccepted
ecosystem services	0.000	0.739	0.580	Unaccepted
education	0.000	0.790	0.597	Unaccepted
energy efficiency	0.500	0.767	0.756	Accepted
environmental sustainability	0.000	0.836	0.612	Unaccepted
evapotranspiration	0.000	0.844	0.615	Unaccepted
farmers	0.250	0.732	0.661	Unaccepted
feed	0.500	0.781	0.760	Accepted
fish	0.000	0.813	0.604	Unaccepted
fisheries	0.000	0.790	0.597	Unaccepted

food consumption	0.000	0.790	0.597	Unaccepted
food loss	0.000	0.768	0.589	Unaccepted
food policy	0.000	0.833	0.611	Unaccepted
food processing	0.500	0.843	0.781	Accepted
food production	0.000	0.790	0.597	Unaccepted
food safety	0.000	0.790	0.597	Unaccepted
food security	0.000	0.790	0.597	Unaccepted
food sovereignty	0.000	0.766	0.589	Unaccepted
food supply chain	0.500	0.819	0.773	Accepted
food sustainability	0.000	0.775	0.592	Unaccepted
food systems	0.500	0.796	0.765	Accepted
food waste	0.250	0.864	0.705	Accepted
food-energy-water nexus	0.500	0.752	0.751	Accepted
governance	0.250	0.755	0.668	Accepted
greenhouse gas emissions	0.000	0.844	0.615	Unaccepted
groundwater	0.000	0.844	0.615	Unaccepted
health	0.250	0.732	0.661	Unaccepted
industrial ecology	0.500	0.781	0.760	Accepted
innovation	0.500	0.843	0.781	Accepted
irrigation	0.000	0.790	0.597	Unaccepted
land use	0.500	0.819	0.773	Accepted
life cycle assessment	0.500	0.796	0.765	Accepted
livelihoods	0.000	0.833	0.611	Unaccepted
livestock	0.250	0.676	0.642	Unaccepted
local food systems	0.500	0.796	0.765	Accepted
logistics	0.500	0.876	0.792	Accepted
maize	0.500	0.804	0.768	Accepted
microalgae	0.000	0.739	0.580	Unaccepted
mitigation	0.000	0.790	0.597	Unaccepted
natural resources	0.250	0.746	0.665	Accepted
nitrogen	0.500	0.867	0.789	Accepted
nutrition	0.000	0.790	0.597	Unaccepted
obesity	0.000	0.813	0.604	Unaccepted
optimization	0.000	0.790	0.597	Unaccepted
organic food	0.000	0.790	0.597	Unaccepted
packaging	0.000	0.790	0.597	Unaccepted
pesticides	0.250	0.795	0.682	Accepted
phosphorus	0.250	0.787	0.679	Accepted
policy	0.000	0.775	0.592	Unaccepted
precision agriculture	0.500	0.796	0.765	Accepted
production	0.000	0.833	0.611	Unaccepted
protein	0.250	0.676	0.642	Unaccepted
public health	0.250	0.755	0.668	Accepted
quality	0.000	0.844	0.615	Unaccepted
remote sensing	0.000	0.844	0.615	Unaccepted
renewable energy	0.500	0.804	0.768	Accepted
resilience	0.500	0.781	0.760	Accepted
retail	0.000	0.813	0.604	Unaccepted
rice	0.000	0.790	0.597	Unaccepted
rural development	0.000	0.790	0.597	Unaccepted
seafood	0.000	0.783	0.594	Unaccepted
short food supply chains	0.000	0.766	0.589	Unaccepted
social-ecological systems	0.500	0.819	0.773	Accepted
solar energy	0.250	0.746	0.665	Accepted
sub - saharan Africa	0.500	0.867	0.789	Accepted
supply chains	0.000	0.783	0.594	Unaccepted

sustainability	0.000	0.664	0.555	Unaccepted
sustainable agriculture	0.250	0.727	0.659	Unaccepted
sustainable consumption	0.000	0.680	0.560	Unaccepted
sustainable diets	0.000	0.783	0.594	Unaccepted
sustainable food	0.500	0.859	0.786	Accepted
sustainable food systems	0.000	0.761	0.587	Unaccepted
sustainable intensification	0.000	0.762	0.587	Unaccepted
sustainable production	0.000	0.790	0.597	Unaccepted
system dynamics	0.000	0.766	0.589	Unaccepted
technology	0.500	0.843	0.781	Accepted
traceability	0.500	0.819	0.773	Accepted
trade	0.000	0.790	0.597	Unaccepted
trade-offs	0.000	0.790	0.597	Unaccepted
transformation	0.000	0.766	0.589	Unaccepted
uncertainty	0.250	0.808	0.686	Accepted
urban agriculture	0.500	0.804	0.768	Accepted
urban farming	0.500	0.796	0.765	Accepted
urban metabolism	0.000	0.833	0.611	Unaccepted
urbanization	0.500	0.752	0.751	Accepted
vegetables	0.250	0.755	0.668	Accepted
virtual water	0.500	0.876	0.792	Accepted
vulnerability	0.500	0.876	0.792	Accepted
waste management	0.250	0.732	0.661	Unaccepted
water footprint	0.250	0.741	0.664	Accepted
water productivity	0.500	0.843	0.781	Accepted
water quality	0.500	0.819	0.773	Accepted
water resources	0.500	0.819	0.773	Accepted
water scarcity	0.500	0.819	0.773	Accepted
water security	0.500	0.819	0.773	Accepted
water use efficiency	0.250	0.795	0.682	Accepted
water-energy-food nexus	0.250	0.746	0.665	Accepted
wheat	0.500	0.867	0.789	Accepted
yield	0.500	0.812	0.771	Accepted
Threshold			**0.663**	

After the second round of FDM, 25 indicators are retained with the value over the threshold of 0.587. The process is explained through Table 5 using the same equations (1)-(4). Table 6 shows final set of indicators after two rounds of FDM analysis, which are named as I1 to I25. In particular, the remaining 25 valid indicators are continuingly used for the next step adopting FDEMATEL method.

Table 5. FDM screening out for indicators (round 2)

Indicators	l	u	S	Decision
adaptation	0.500	0.789	0.763	Accepted
agriculture	0.000	0.000	0.333	Unaccepted
agroecology	0.000	0.758	0.586	Unaccepted
alternative food networks	0.500	0.781	0.760	Accepted
aquaculture	0.000	0.762	0.587	Unaccepted
biodiversity	0.250	0.783	0.678	Accepted
bioenergy	0.000	0.761	0.587	Unaccepted
biomass	0.000	0.758	0.586	Unaccepted
blockchain	0.250	0.832	0.694	Accepted

carbon footprint	0.500	0.835	0.778	Accepted
circular economy	0.500	0.827	0.776	Accepted
climate change	0.000	0.758	0.586	Unaccepted
corporate social responsibility	0.000	0.758	0.586	Unaccepted
ecosystem services	0.000	0.722	0.574	Unaccepted
environmental sustainability	0.000	0.000	0.333	Unaccepted
food consumption	0.250	0.777	0.676	Accepted
food policy	0.000	0.762	0.587	Unaccepted
food production	0.000	0.000	0.333	Unaccepted
food safety	0.250	0.840	0.697	Accepted
food security	0.250	0.775	0.675	Accepted
food sovereignty	0.000	0.759	0.586	Unaccepted
food systems	0.000	0.000	0.333	Unaccepted
food waste	0.000	0.761	0.587	Unaccepted
governance	0.500	0.859	0.786	Accepted
greenhouse gas emissions	0.000	0.000	0.333	Unaccepted
Halal certification	0.250	0.761	0.670	Accepted
Halal certification and labelling	0.000	0.761	0.587	Unaccepted
Halal food	0.000	0.761	0.587	Unaccepted
Halal industry	0.000	0.596	0.532	Unaccepted
Halal inspection	0.000	0.761	0.587	Unaccepted
Halal practices integrity	0.250	0.798	0.683	Accepted
Halal product	0.000	0.761	0.587	Unaccepted
Halal supply chain trust	0.250	0.808	0.686	Accepted
innovation	0.000	0.748	0.583	Unaccepted
Islamic manufacturing practices	0.000	0.761	0.587	Unaccepted
Islamic values	0.250	0.798	0.683	Accepted
life cycle assessment	0.000	0.000	0.333	Unaccepted
livelihoods	0.000	0.000	0.333	Unaccepted
livestock	0.000	0.761	0.587	Unaccepted
microalgae	0.000	0.758	0.586	Unaccepted
nitrogen	0.000	0.000	0.333	Unaccepted
nutrition	0.000	0.000	0.333	Unaccepted
packaging	0.250	0.769	0.673	Accepted
perception	0.000	0.000	0.333	Unaccepted
pesticides	0.000	0.707	0.569	Unaccepted
policy	0.000	0.762	0.587	Unaccepted
precision agriculture	0.000	0.762	0.587	Unaccepted
production	0.250	0.510	0.587	Unaccepted
protein	0.000	0.758	0.586	Unaccepted
purchase intention	0.500	0.859	0.786	Accepted
quality	0.000	0.610	0.537	Unaccepted
remote sensing	0.500	0.827	0.776	Accepted
renewable energy	0.500	0.843	0.781	Accepted
resilience	0.500	0.843	0.781	Accepted
retail	0.000	0.739	0.580	Unaccepted
rice	0.000	0.000	0.333	Unaccepted
risks	0.000	0.000	0.333	Unaccepted
rural development	0.000	0.000	0.333	Unaccepted
seafood	0.000	0.000	0.333	Unaccepted
supply chain management	0.500	0.859	0.786	Accepted
supply chain performance	0.500	0.876	0.792	Accepted
sustainable agriculture	0.000	0.759	0.586	Unaccepted
sustainable diets	0.000	0.703	0.568	Unaccepted
sustainable food	0.500	0.827	0.776	Accepted
sustainable food systems	0.250	0.510	0.587	Unaccepted

sustainable intensification	0.000	0.761	0.587	Unaccepted
system dynamics	0.500	0.827	0.776	Accepted
technology	0.000	0.762	0.587	Unaccepted
traceability	0.500	0.819	0.773	Accepted
urbanization	0.000	0.759	0.586	Unaccepted
waste management	0.500	0.819	0.773	Accepted
water footprint	0.000	0.718	0.573	Unaccepted
water productivity	0.000	0.761	0.587	Unaccepted
water quality	0.000	0.735	0.578	Unaccepted
water resources	0.000	0.748	0.583	Unaccepted
water scarcity	0.000	0.759	0.586	Unaccepted
water security	0.000	0.755	0.585	Unaccepted
water use efficiency	0.000	0.711	0.570	Unaccepted
Threshold			**0.587**	

Table 6. FDM result for indicators

Indicator	
I1	adaptation
I2	alternative food networks
I3	biodiversity
I4	blockchain
I5	carbon footprint
I6	circular economy
I7	food consumption
I8	food safety
I9	food security
I10	governance
I11	Halal certification
I12	Halal practices integrity
I13	Halal supply chain trust
I14	Islamic values
I15	packaging
I16	purchase intention
I17	remote sensing
I18	renewable energy
I19	resilience
I20	supply chain management
I21	supply chain performance
I22	sustainable food
I23	system dynamics
I24	traceability
I25	waste management

4.3. Step 4 - FDEMATEL results

4.3.1. Non-Halal SFSC

Table 7 illustrates the crisp values of indicators, which are calculated through equations (5)-(7). The data reflects the average interrelationship value of one indicator on the other. The data from this table then is used as the initial input for calculating total interrelationship matrix. The total interrelation of indicators in non-Halal SFSC is presented in Table 8 applying the equations (8)-(13). Based on the $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ values, indicators are mapped into cause-and-effect diagrams, in which $(\boldsymbol{\alpha}+\boldsymbol{\beta})$ represents for the horizontal axis while $(\boldsymbol{\alpha}-\boldsymbol{\beta})$ represents for the vertical axis. In Figure 2, the most important indicators consist of food consumption (I7), food safety (I8), food security (I9), resilience (I19) and waste management (I25). Since these indicators have significant impact on others, improving them has critical effect on non-Halal SFSC. Thus, the discussion on non-Halal SFSC should be distributed based on these indicators.

Table 7. Crisp value of indicators in non-Halal sustainable food supply chain

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19	I20	I21	I22	I23	I24	I25
I1	0.821	0.535	0.289	0.395	0.289	0.338	0.306	0.336	0.372	0.440	0.326	0.406	0.298	0.375	0.345	0.272	0.376	0.410	0.344	0.450	0.494	0.381	0.309	0.370	0.371
I2	0.506	0.829	0.278	0.369	0.330	0.492	0.487	0.405	0.437	0.407	0.261	0.435	0.365	0.315	0.368	0.348	0.387	0.433	0.304	0.539	0.404	0.560	0.423	0.433	0.383
I3	0.373	0.380	0.829	0.224	0.276	0.363	0.428	0.392	0.464	0.325	0.352	0.267	0.301	0.340	0.361	0.309	0.236	0.331	0.296	0.409	0.392	0.459	0.373	0.371	0.410
I4	0.334	0.340	0.383	0.810	0.357	0.455	0.374	0.391	0.388	0.247	0.275	0.373	0.276	0.392	0.267	0.206	0.269	0.239	0.256	0.498	0.392	0.368	0.345	0.268	0.269
I5	0.273	0.341	0.418	0.369	0.812	0.456	0.330	0.364	0.426	0.406	0.353	0.321	0.185	0.316	0.348	0.221	0.414	0.345	0.335	0.490	0.467	0.512	0.305	0.421	0.356
I6	0.360	0.392	0.327	0.303	0.357	0.784	0.382	0.366	0.413	0.453	0.340	0.332	0.257	0.300	0.474	0.282	0.364	0.369	0.269	0.502	0.456	0.408	0.284	0.317	0.436
I7	0.399	0.495	0.352	0.407	0.457	0.338	0.794	0.453	0.442	0.531	0.520	0.383	0.452	0.504	0.550	0.388	0.362	0.434	0.551	0.377	0.382	0.450	0.269	0.356	0.281
I8	0.411	0.572	0.480	0.405	0.470	0.365	0.416	0.785	0.529	0.521	0.428	0.448	0.468	0.493	0.460	0.320	0.375	0.485	0.446	0.512	0.453	0.548	0.332	0.342	0.292
I9	0.336	0.485	0.416	0.405	0.404	0.441	0.381	0.389	0.801	0.485	0.433	0.422	0.425	0.323	0.510	0.371	0.411	0.486	0.473	0.549	0.440	0.550	0.370	0.381	0.344
I10	0.283	0.561	0.174	0.316	0.303	0.482	0.302	0.351	0.324	0.785	0.394	0.321	0.413	0.340	0.282	0.284	0.443	0.344	0.423	0.411	0.350	0.447	0.348	0.344	0.358
I11	0.374	0.508	0.454	0.443	0.419	0.469	0.369	0.222	0.416	0.391	0.785	0.243	0.404	0.402	0.433	0.283	0.400	0.422	0.435	0.382	0.425	0.549	0.322	0.396	0.410
I12	0.360	0.392	0.173	0.342	0.316	0.430	0.335	0.288	0.311	0.407	0.354	0.794	0.390	0.403	0.322	0.361	0.379	0.411	0.323	0.436	0.324	0.293	0.361	0.306	0.305
I13	0.296	0.445	0.276	0.423	0.250	0.379	0.303	0.339	0.428	0.496	0.340	0.436	1.000	0.380	0.396	0.272	0.417	0.449	0.310	0.411	0.440	0.512	0.270	0.404	0.369
I14	0.375	0.381	0.198	0.328	0.357	0.367	0.298	0.415	0.443	0.406	0.405	0.372	0.463	0.785	0.459	0.296	0.325	0.450	0.358	0.447	0.481	0.526	0.349	0.435	0.410
I15	0.414	0.523	0.235	0.406	0.327	0.429	0.244	0.378	0.363	0.470	0.458	0.421	0.313	0.378	0.796	0.363	0.376	0.384	0.457	0.298	0.373	0.460	0.335	0.396	0.332
I16	0.374	0.287	0.366	0.292	0.317	0.354	0.274	0.248	0.299	0.234	0.365	0.384	0.430	0.442	0.152	0.822	0.287	0.265	0.283	0.435	0.365	0.421	0.323	0.217	0.382
I17	0.324	0.418	0.263	0.508	0.316	0.339	0.423	0.443	0.249	0.353	0.426	0.358	0.379	0.404	0.269	0.310	0.805	0.371	0.283	0.476	0.418	0.345	0.229	0.256	0.307
I18	0.335	0.445	0.455	0.395	0.303	0.456	0.377	0.342	0.325	0.366	0.368	0.322	0.406	0.428	0.323	0.296	0.390	0.794	0.370	0.319	0.428	0.472	0.309	0.308	0.397
I19	0.325	0.456	0.417	0.329	0.410	0.405	0.391	0.535	0.496	0.354	0.559	0.509	0.427	0.515	0.587	0.271	0.224	0.368	0.794	0.470	0.543	0.487	0.375	0.344	0.331
I20	0.244	0.315	0.314	0.435	0.254	0.468	0.338	0.325	0.351	0.326	0.456	0.435	0.385	0.481	0.446	0.385	0.363	0.318	0.347	0.772	0.504	0.421	0.460	0.280	0.370
I21	0.388	0.355	0.355	0.473	0.277	0.288	0.280	0.291	0.248	0.381	0.495	0.501	0.295	0.416	0.357	0.413	0.324	0.252	0.346	0.511	0.771	0.460	0.364	0.407	0.434
I22	0.270	0.406	0.353	0.315	0.330	0.376	0.275	0.366	0.338	0.420	0.559	0.406	0.309	0.429	0.420	0.335	0.234	0.332	0.368	0.553	0.478	0.796	0.359	0.430	0.407
I23	0.348	0.408	0.327	0.433	0.330	0.469	0.326	0.362	0.373	0.533	0.458	0.381	0.350	0.464	0.445	0.347	0.321	0.330	0.335	0.516	0.414	0.358	0.777	0.329	0.331
I24	0.324	0.470	0.430	0.521	0.394	0.469	0.350	0.352	0.404	0.482	0.457	0.307	0.341	0.376	0.370	0.453	0.441	0.423	0.308	0.466	0.416	0.279	0.323	0.809	0.293
I25	0.349	0.459	0.392	0.468	0.496	0.556	0.376	0.403	0.404	0.507	0.431	0.294	0.362	0.413	0.484	0.415	0.403	0.461	0.357	0.465	0.379	0.500	0.450	0.435	0.793

Table 8. Total interrelationship matrix of indicators in non-Halal sustainable food supply chain

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19	I20	I21	I22	I23	I24	I25	α
I1	0.295	0.319	0.239	0.279	0.244	0.291	0.247	0.259	0.274	0.298	0.285	0.275	0.259	0.284	0.278	0.230	0.258	0.275	0.256	0.324	0.311	0.314	0.244	0.259	0.259	**6.856**
I2	0.287	0.371	0.258	0.299	0.268	0.329	0.284	0.286	0.303	0.319	0.303	0.300	0.287	0.302	0.303	0.257	0.280	0.299	0.273	0.359	0.327	0.357	0.274	0.285	0.281	**7.489**
I3	0.246	0.295	0.282	0.254	0.236	0.284	0.250	0.256	0.275	0.279	0.279	0.253	0.251	0.272	0.271	0.227	0.237	0.259	0.244	0.310	0.292	0.312	0.242	0.251	0.255	**6.613**
I4	0.230	0.275	0.228	0.294	0.230	0.277	0.233	0.243	0.254	0.256	0.256	0.250	0.235	0.262	0.248	0.205	0.227	0.237	0.227	0.302	0.276	0.287	0.227	0.228	0.229	**6.215**
I5	0.243	0.299	0.250	0.275	0.291	0.300	0.248	0.260	0.278	0.293	0.286	0.265	0.246	0.277	0.277	0.224	0.260	0.267	0.254	0.326	0.307	0.325	0.242	0.262	0.257	**6.813**
I6	0.250	0.303	0.240	0.268	0.248	0.329	0.251	0.259	0.276	0.297	0.284	0.265	0.252	0.274	0.287	0.229	0.254	0.269	0.247	0.326	0.304	0.314	0.239	0.251	0.263	**6.779**
I7	0.287	0.354	0.275	0.314	0.291	0.327	0.322	0.302	0.315	0.343	0.339	0.306	0.307	0.332	0.332	0.270	0.288	0.311	0.308	0.357	0.338	0.361	0.270	0.289	0.283	**7.820**
I8	0.298	0.373	0.296	0.325	0.301	0.341	0.298	0.342	0.334	0.354	0.342	0.323	0.318	0.342	0.334	0.273	0.299	0.326	0.307	0.382	0.356	0.382	0.286	0.298	0.294	**8.124**
I9	0.283	0.354	0.283	0.316	0.287	0.339	0.286	0.298	0.349	0.341	0.333	0.312	0.306	0.317	0.330	0.270	0.294	0.317	0.302	0.375	0.345	0.372	0.281	0.293	0.290	**7.873**
I10	0.240	0.315	0.223	0.266	0.240	0.298	0.241	0.255	0.264	0.323	0.285	0.261	0.265	0.275	0.266	0.226	0.259	0.263	0.258	0.313	0.291	0.314	0.242	0.250	0.253	**6.683**
I11	0.271	0.337	0.271	0.302	0.273	0.323	0.269	0.266	0.297	0.313	0.347	0.278	0.287	0.306	0.305	0.247	0.277	0.294	0.282	0.339	0.325	0.352	0.261	0.279	0.281	**7.381**
I12	0.240	0.290	0.215	0.260	0.234	0.284	0.236	0.241	0.254	0.280	0.272	0.296	0.255	0.272	0.261	0.227	0.245	0.261	0.241	0.306	0.279	0.290	0.236	0.239	0.240	**6.452**
I13	0.256	0.322	0.246	0.292	0.249	0.305	0.255	0.268	0.290	0.315	0.297	0.288	0.335	0.295	0.293	0.239	0.271	0.289	0.262	0.332	0.317	0.339	0.249	0.271	0.269	**7.143**
I14	0.266	0.320	0.242	0.287	0.263	0.308	0.258	0.279	0.294	0.310	0.307	0.285	0.288	0.336	0.302	0.244	0.266	0.292	0.270	0.339	0.324	0.344	0.259	0.278	0.276	**7.238**
I15	0.265	0.326	0.240	0.287	0.255	0.307	0.247	0.270	0.281	0.309	0.305	0.284	0.268	0.292	0.326	0.245	0.265	0.280	0.273	0.318	0.307	0.330	0.252	0.268	0.263	**7.064**
I16	0.229	0.264	0.222	0.242	0.222	0.262	0.219	0.224	0.240	0.249	0.260	0.246	0.246	0.262	0.231	0.258	0.224	0.234	0.224	0.291	0.269	0.286	0.220	0.219	0.235	**6.078**
I17	0.240	0.297	0.228	0.280	0.238	0.280	0.249	0.259	0.253	0.279	0.284	0.261	0.258	0.277	0.260	0.225	0.288	0.262	0.241	0.315	0.293	0.300	0.227	0.238	0.244	**6.574**
I18	0.252	0.313	0.257	0.281	0.248	0.304	0.256	0.262	0.273	0.294	0.291	0.269	0.272	0.292	0.278	0.234	0.261	0.312	0.260	0.314	0.307	0.326	0.245	0.255	0.264	**6.920**
I19	0.281	0.351	0.282	0.308	0.287	0.334	0.286	0.310	0.321	0.328	0.344	0.319	0.305	0.333	0.337	0.260	0.275	0.305	0.330	0.366	0.353	0.365	0.281	0.289	0.288	**7.837**
I20	0.245	0.302	0.244	0.286	0.244	0.306	0.252	0.261	0.276	0.291	0.301	0.281	0.271	0.298	0.291	0.244	0.259	0.269	0.259	0.357	0.315	0.322	0.261	0.253	0.262	**6.950**
I21	0.255	0.302	0.245	0.286	0.243	0.286	0.244	0.254	0.262	0.292	0.301	0.284	0.259	0.288	0.278	0.244	0.253	0.260	0.256	0.330	0.335	0.321	0.249	0.262	0.265	**6.853**
I22	0.250	0.314	0.251	0.278	0.254	0.301	0.249	0.267	0.277	0.303	0.314	0.281	0.266	0.296	0.291	0.242	0.250	0.274	0.264	0.341	0.316	0.360	0.254	0.270	0.269	**7.031**
I23	0.261	0.319	0.252	0.293	0.257	0.314	0.258	0.271	0.285	0.318	0.308	0.283	0.274	0.303	0.298	0.246	0.262	0.278	0.265	0.342	0.315	0.325	0.296	0.264	0.265	**7.154**
I24	0.263	0.329	0.266	0.306	0.267	0.319	0.264	0.274	0.292	0.317	0.312	0.280	0.277	0.299	0.294	0.260	0.278	0.290	0.266	0.342	0.319	0.322	0.258	0.312	0.266	**7.272**
I25	0.284	0.352	0.281	0.322	0.297	0.350	0.286	0.299	0.314	0.343	0.333	0.300	0.300	0.325	0.328	0.275	0.294	0.315	0.291	0.368	0.340	0.368	0.289	0.298	0.332	**7.883**
$\boldsymbol{\beta}$	**6.516**	**7.996**	**6.316**	**7.201**	**6.467**	**7.697**	**6.489**	**6.763**	**7.132**	**7.644**	**7.568**	**7.045**	**6.884**	**7.411**	**7.299**	**6.102**	**6.623**	**7.039**	**6.659**	**8.375**	**7.857**	**8.287**	**6.382**	**6.662**	**6.681**	

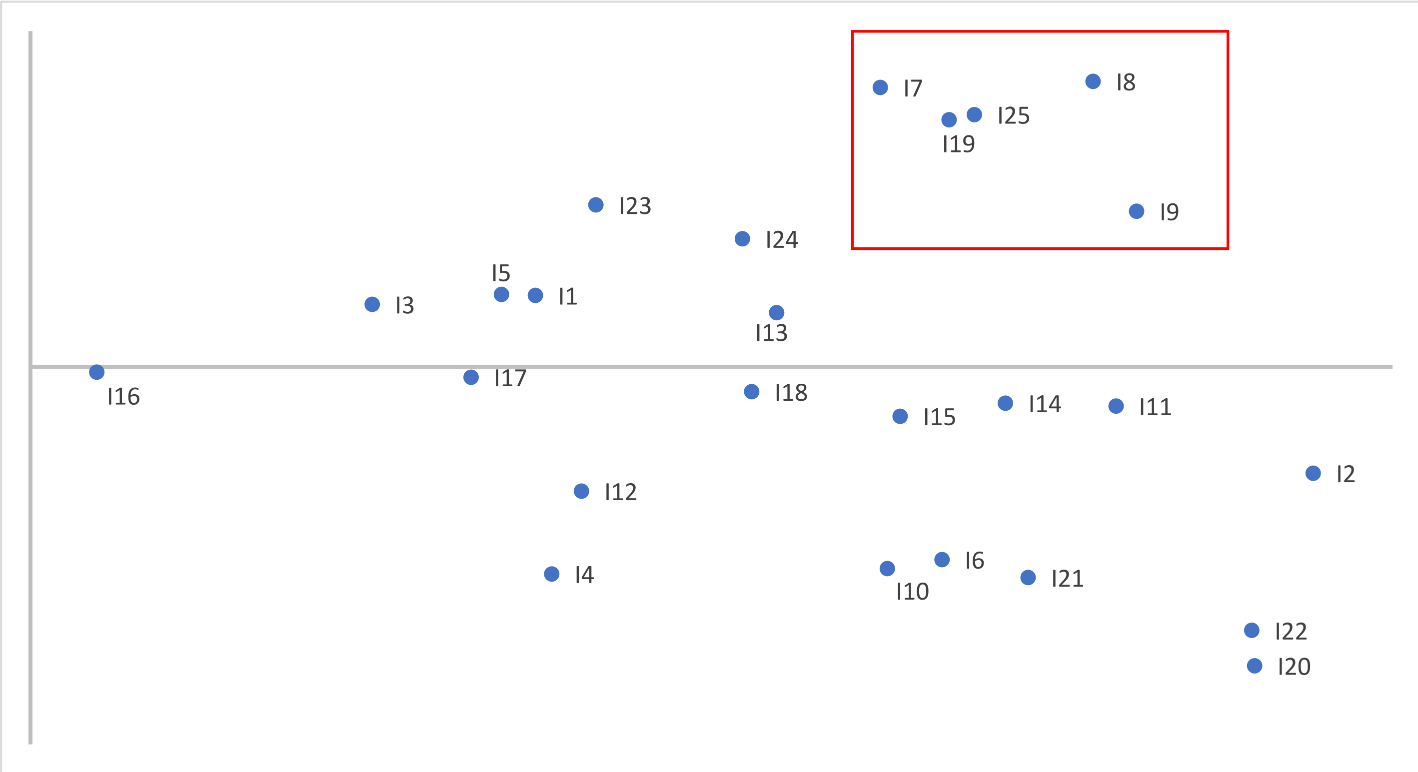


Figure 2. Cause-and-effect diagram of indicators in non-Halal sustainable food supply chain

4.3.2. Halal SFSC

Similarly, Table 9 presents the crisp values of indicators for Halal sustainable food supply chain using the equations (5)-(7). Applying the same procedure as for non-Halal SFSC indicators, Table 10 displays the total interrelations of indicators in Halal SFSC applying the equations (8)-(13). In Figure 3, the critical indicators include I8, I11, I13 and I14. As the most important indicators in Halal SFSC, food safety (I8), halal certification (I11), Halal SC trust (I13) and Islamic values (I14) have significant impact on others. Hence, the discussion should be distributed based on these indicators to improve the Halal SFSC.

Table 9. Crisp value of indicators in Halal sustainable food supply chain

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19	I20	I21	I22	I23	I24	I25
I1	0.807	0.475	0.384	0.346	0.471	0.373	0.567	0.450	0.383	0.333	0.425	0.477	0.385	0.440	0.573	0.444	0.396	0.379	0.198	0.475	0.486	0.502	0.356	0.502	0.653
I2	0.453	0.798	0.500	0.296	0.493	0.346	0.442	0.372	0.354	0.334	0.413	0.411	0.348	0.464	0.560	0.459	0.189	0.325	0.325	0.536	0.460	0.543	0.330	0.452	0.401
I3	0.476	0.539	0.784	0.217	0.443	0.419	0.583	0.521	0.560	0.356	0.453	0.446	0.398	0.340	0.583	0.570	0.419	0.298	0.301	0.446	0.563	0.517	0.419	0.372	0.593
I4	0.222	0.347	0.204	0.780	0.342	0.421	0.346	0.422	0.534	0.477	0.429	0.485	0.522	0.300	0.469	0.397	0.381	0.415	0.325	0.450	0.424	0.351	0.369	0.387	0.414
I5	0.363	0.486	0.471	0.373	0.772	0.506	0.560	0.564	0.462	0.559	0.578	0.574	0.484	0.545	0.575	0.594	0.293	0.390	0.521	0.555	0.576	0.543	0.408	0.568	0.581
I6	0.388	0.395	0.436	0.381	0.519	0.737	0.461	0.334	0.432	0.487	0.517	0.573	0.559	0.465	0.546	0.549	0.318	0.506	0.440	0.577	0.564	0.543	0.432	0.374	0.567
I7	0.399	0.627	0.521	0.321	0.612	0.576	0.779	0.534	0.547	0.435	0.550	0.496	0.508	0.507	0.497	0.523	0.318	0.366	0.377	0.436	0.575	0.553	0.164	0.542	0.542
I8	0.321	0.497	0.559	0.524	0.584	0.528	0.586	0.788	0.586	0.501	0.555	0.600	0.506	0.581	0.546	0.569	0.396	0.375	0.401	0.566	0.615	0.508	0.214	0.504	0.577
I9	0.247	0.434	0.446	0.432	0.572	0.409	0.499	0.423	0.809	0.471	0.555	0.551	0.484	0.493	0.560	0.559	0.266	0.568	0.375	0.575	0.614	0.591	0.367	0.592	0.577
I10	0.401	0.292	0.254	0.515	0.517	0.470	0.416	0.510	0.547	0.784	0.525	0.435	0.485	0.480	0.443	0.519	0.280	0.518	0.454	0.512	0.603	0.505	0.343	0.466	0.498
I11	0.321	0.381	0.369	0.412	0.542	0.563	0.561	0.499	0.506	0.509	0.756	0.602	0.534	0.534	0.468	0.583	0.523	0.406	0.489	0.589	0.590	0.568	0.415	0.552	0.555
I12	0.453	0.398	0.484	0.509	0.620	0.543	0.500	0.498	0.508	0.637	0.501	0.782	0.519	0.493	0.495	0.522	0.370	0.494	0.425	0.602	0.615	0.476	0.355	0.424	0.613
I13	0.375	0.486	0.394	0.472	0.609	0.538	0.476	0.603	0.573	0.511	0.588	0.603	1.000	0.405	0.367	0.531	0.461	0.481	0.529	0.564	0.553	0.531	0.201	0.558	0.504
I14	0.222	0.613	0.329	0.349	0.559	0.550	0.594	0.574	0.584	0.536	0.465	0.578	0.445	0.800	0.581	0.548	0.355	0.441	0.417	0.514	0.527	0.415	0.370	0.581	0.629
I15	0.377	0.566	0.360	0.361	0.532	0.518	0.654	0.472	0.435	0.509	0.414	0.539	0.399	0.512	0.778	0.507	0.384	0.430	0.391	0.474	0.578	0.520	0.239	0.488	0.628
I16	0.398	0.469	0.486	0.499	0.543	0.503	0.481	0.550	0.560	0.559	0.462	0.577	0.558	0.458	0.430	0.748	0.526	0.354	0.374	0.528	0.528	0.520	0.446	0.581	0.628
I17	0.208	0.267	0.308	0.269	0.459	0.394	0.367	0.335	0.372	0.343	0.494	0.542	0.399	0.418	0.303	0.547	0.798	0.238	0.351	0.427	0.452	0.465	0.264	0.440	0.490
I18	0.476	0.358	0.495	0.423	0.521	0.503	0.501	0.445	0.572	0.523	0.529	0.476	0.535	0.505	0.482	0.548	0.344	0.775	0.467	0.627	0.489	0.568	0.391	0.555	0.525
I19	0.259	0.354	0.470	0.329	0.454	0.393	0.526	0.411	0.622	0.463	0.454	0.516	0.448	0.467	0.339	0.523	0.472	0.361	0.788	0.538	0.589	0.517	0.370	0.556	0.605
I20	0.306	0.472	0.460	0.370	0.518	0.466	0.482	0.448	0.534	0.570	0.525	0.574	0.548	0.494	0.520	0.561	0.445	0.401	0.428	0.776	0.615	0.581	0.409	0.593	0.512
I21	0.335	0.354	0.495	0.357	0.555	0.467	0.525	0.460	0.547	0.575	0.516	0.567	0.532	0.364	0.510	0.510	0.357	0.556	0.413	0.590	0.776	0.580	0.393	0.516	0.629
I22	0.397	0.367	0.371	0.372	0.555	0.502	0.539	0.437	0.446	0.495	0.555	0.600	0.522	0.366	0.485	0.535	0.315	0.425	0.402	0.499	0.639	0.778	0.287	0.558	0.665
I23	0.271	0.256	0.244	0.256	0.404	0.361	0.363	0.447	0.445	0.384	0.424	0.474	0.419	0.378	0.314	0.522	0.381	0.327	0.351	0.555	0.580	0.452	0.802	0.605	0.568
I24	0.414	0.268	0.372	0.361	0.583	0.551	0.529	0.525	0.651	0.436	0.520	0.513	0.467	0.403	0.535	0.486	0.420	0.407	0.416	0.500	0.511	0.489	0.501	0.765	0.556
I25	0.567	0.385	0.482	0.399	0.620	0.528	0.587	0.537	0.551	0.561	0.426	0.502	0.482	0.547	0.581	0.512	0.446	0.479	0.404	0.507	0.523	0.479	0.511	0.544	0.743

Table 10. Total interrelationship matrix of indicators in Halal sustainable food supply chain

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19	I20	I21	I22	I23	I24	I25	α
I1	0.453	0.486	0.472	0.436	0.595	0.535	0.580	0.539	0.572	0.540	0.555	0.596	0.548	0.521	0.565	0.586	0.433	0.474	0.443	0.591	0.620	0.581	0.410	0.579	0.640	**13.351**
I2	0.401	0.485	0.455	0.408	0.563	0.502	0.538	0.502	0.538	0.510	0.523	0.557	0.513	0.493	0.533	0.554	0.392	0.443	0.427	0.563	0.583	0.552	0.385	0.543	0.585	**12.548**
I3	0.438	0.505	0.518	0.439	0.610	0.554	0.598	0.560	0.603	0.558	0.574	0.611	0.565	0.528	0.582	0.614	0.447	0.481	0.464	0.606	0.644	0.599	0.426	0.586	0.654	**13.765**
I4	0.367	0.431	0.414	0.432	0.530	0.489	0.510	0.487	0.532	0.502	0.505	0.542	0.509	0.462	0.505	0.529	0.393	0.434	0.412	0.536	0.558	0.516	0.373	0.518	0.563	**12.051**
I5	0.476	0.555	0.546	0.501	0.704	0.622	0.661	0.624	0.662	0.637	0.647	0.689	0.634	0.603	0.644	0.682	0.485	0.542	0.534	0.682	0.716	0.666	0.472	0.667	0.724	**15.375**
I6	0.449	0.514	0.511	0.471	0.642	0.603	0.613	0.569	0.619	0.594	0.604	0.647	0.602	0.560	0.603	0.638	0.458	0.519	0.496	0.643	0.672	0.627	0.446	0.611	0.679	**14.392**
I7	0.458	0.542	0.527	0.475	0.661	0.601	0.650	0.595	0.639	0.599	0.617	0.653	0.609	0.574	0.610	0.647	0.466	0.517	0.500	0.643	0.684	0.638	0.431	0.635	0.689	**14.660**
I8	0.475	0.559	0.557	0.516	0.693	0.628	0.667	0.645	0.675	0.636	0.649	0.695	0.640	0.609	0.645	0.684	0.496	0.544	0.528	0.687	0.723	0.667	0.459	0.665	0.728	**15.469**
I9	0.452	0.534	0.528	0.491	0.667	0.596	0.636	0.594	0.669	0.611	0.626	0.666	0.615	0.580	0.623	0.659	0.468	0.540	0.507	0.663	0.697	0.650	0.455	0.649	0.702	**14.878**
I10	0.439	0.493	0.483	0.471	0.626	0.567	0.594	0.568	0.613	0.602	0.590	0.620	0.582	0.548	0.580	0.620	0.443	0.508	0.485	0.622	0.658	0.608	0.428	0.603	0.657	**14.008**
I11	0.468	0.542	0.534	0.500	0.680	0.622	0.656	0.614	0.660	0.628	0.656	0.686	0.634	0.597	0.630	0.676	0.500	0.539	0.528	0.680	0.711	0.663	0.469	0.661	0.716	**15.254**
I12	0.480	0.544	0.544	0.509	0.687	0.621	0.652	0.615	0.661	0.639	0.637	0.700	0.633	0.595	0.633	0.672	0.488	0.547	0.523	0.681	0.714	0.657	0.465	0.651	0.722	**15.271**
I13	0.477	0.555	0.541	0.510	0.692	0.626	0.655	0.628	0.672	0.634	0.649	0.692	0.677	0.592	0.628	0.678	0.500	0.550	0.536	0.684	0.714	0.666	0.455	0.667	0.718	**15.397**
I14	0.453	0.552	0.522	0.487	0.671	0.611	0.648	0.610	0.656	0.620	0.623	0.673	0.616	0.609	0.629	0.662	0.478	0.534	0.514	0.663	0.694	0.640	0.457	0.652	0.710	**14.984**
I15	0.447	0.527	0.503	0.468	0.641	0.584	0.627	0.578	0.617	0.593	0.593	0.642	0.587	0.562	0.619	0.632	0.461	0.511	0.490	0.632	0.670	0.622	0.428	0.618	0.682	**14.338**
I16	0.471	0.544	0.539	0.503	0.675	0.612	0.644	0.614	0.659	0.627	0.628	0.678	0.631	0.586	0.622	0.684	0.497	0.531	0.514	0.669	0.701	0.654	0.468	0.657	0.716	**15.128**
I17	0.358	0.416	0.414	0.382	0.529	0.477	0.501	0.470	0.508	0.481	0.500	0.536	0.488	0.462	0.481	0.530	0.418	0.410	0.405	0.522	0.549	0.514	0.357	0.511	0.558	**11.779**
I18	0.475	0.533	0.537	0.494	0.669	0.609	0.642	0.602	0.656	0.621	0.630	0.666	0.625	0.587	0.623	0.664	0.479	0.561	0.519	0.673	0.693	0.654	0.461	0.652	0.704	**15.029**
I19	0.428	0.499	0.502	0.456	0.623	0.562	0.605	0.562	0.621	0.578	0.585	0.628	0.580	0.548	0.573	0.622	0.460	0.496	0.513	0.625	0.659	0.610	0.431	0.612	0.667	**14.044**
I20	0.460	0.540	0.532	0.489	0.667	0.604	0.639	0.600	0.652	0.623	0.628	0.672	0.624	0.584	0.624	0.663	0.486	0.530	0.514	0.683	0.702	0.654	0.461	0.653	0.701	**14.985**
I21	0.459	0.527	0.532	0.484	0.666	0.600	0.638	0.597	0.648	0.619	0.623	0.667	0.619	0.570	0.619	0.655	0.475	0.539	0.510	0.664	0.709	0.649	0.456	0.642	0.705	**14.871**
I22	0.452	0.514	0.508	0.473	0.648	0.587	0.622	0.579	0.623	0.597	0.609	0.652	0.602	0.555	0.600	0.639	0.460	0.515	0.495	0.639	0.680	0.647	0.436	0.628	0.690	**14.449**
I23	0.386	0.441	0.434	0.405	0.557	0.504	0.532	0.509	0.546	0.514	0.525	0.563	0.520	0.486	0.512	0.560	0.408	0.443	0.430	0.565	0.593	0.545	0.423	0.556	0.598	**12.554**
I24	0.454	0.507	0.509	0.472	0.651	0.592	0.622	0.587	0.640	0.593	0.608	0.646	0.598	0.559	0.605	0.637	0.469	0.514	0.497	0.640	0.671	0.626	0.454	0.646	0.683	**14.481**
I25	0.490	0.544	0.545	0.501	0.689	0.621	0.660	0.620	0.666	0.634	0.632	0.680	0.631	0.600	0.641	0.673	0.496	0.547	0.522	0.675	0.708	0.658	0.478	0.662	0.734	**15.307**
β	**11.168**	**12.888**	**12.708**	**11.774**	**16.038**	**14.527**	**15.391**	**14.470**	**15.606**	**14.793**	**15.017**	**16.059**	**14.882**	**13.969**	**14.929**	**15.861**	**11.557**	**12.769**	**12.307**	**15.932**	**16.722**	**15.566**	**10.982**	**15.525**	**16.927**	**0.573**

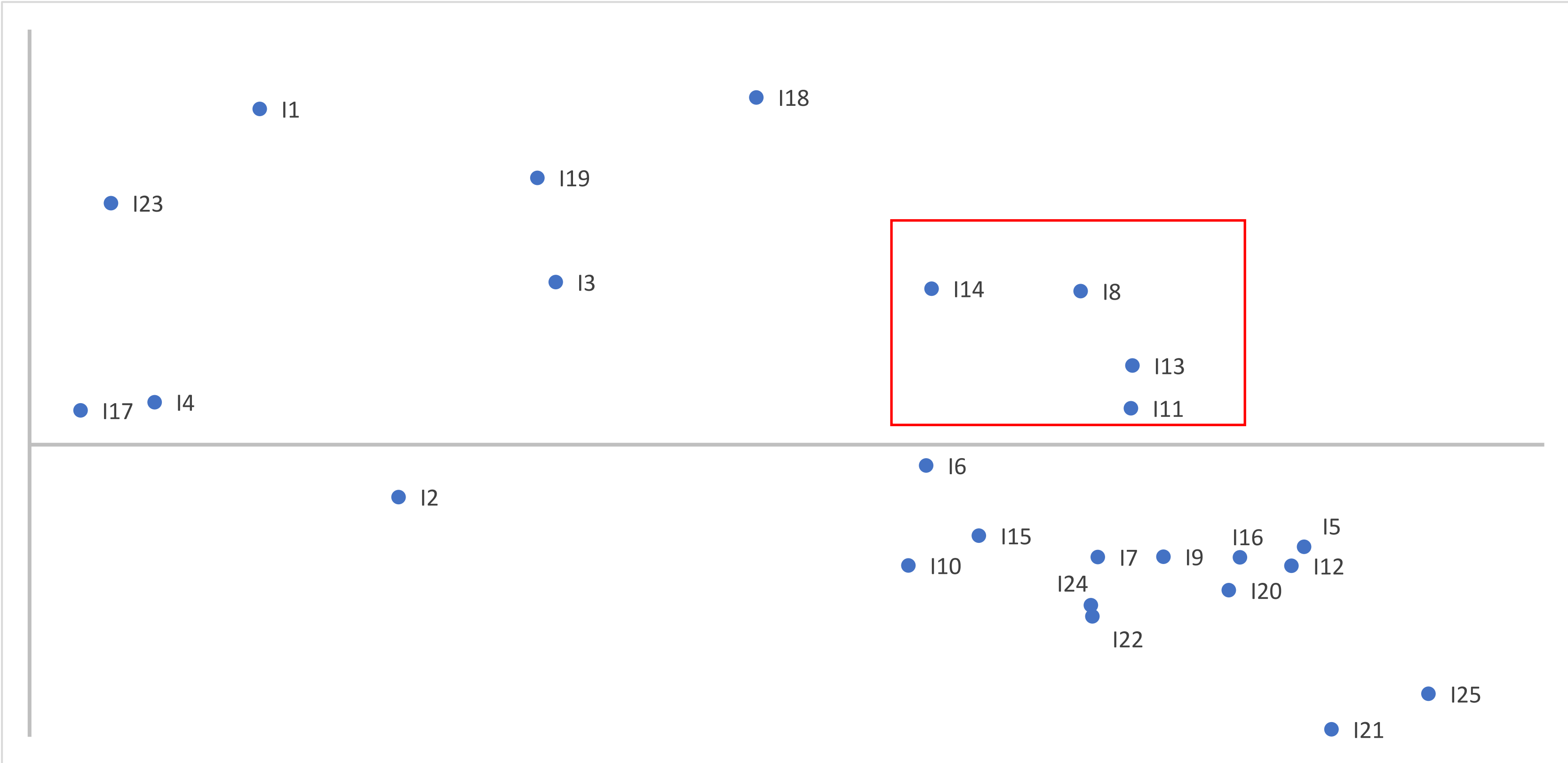


Figure 3. Cause-and-effect diagram of indicators in Halal sustainable food supply chain

5. Discussion and future challenges and opportunities

5.1. Non-halal sustainable food supply chain

5.1.1. Food consumption

The consumption towards SFSC is a consumer-driven, complete definition referring to customer’s food demand that requires the integration of implementing sustainable living styles, food waste management, and recycle; moreover, caring of natural ecosystems' capacities (Govindan, 2018). The indicator has recently received high attention, especially related to the diet composition according to various dimensions like health, expense, and sustainable living styles (Rohmer et al., 2019). However, the indicator has been proved as a direct source of food spoilage since it is related to customer relationship which impacts purchasing decision (Ali et al., 2019). Altering consumption habits is necessary and it requires the incorporation of the whole chain, especially SC planners to persuade consumers to buy sustainable foods through appropriate promotion strategies. Furthermore, the living area also affects the customers' food consumption, such as people in urban areas were studied that having different consuming ways compare with people in rural counterparts (Boyer et al., 2019). Yet, the reason why there is consumption variation within and between urban areas still needs to be researched and clarified. Although divergent aspects of urbanization such as area expansion, urban structure, and lifestyles are argued to affect food systems and how people consume food, the impact level of these dimensions on food consumption is not well interpreted (d’Amour et al., 2020).

The increasing population all over the world has risen food consumption, then created unwanted effects on the environment such as global warming and natural resource depletion, which requires higher acknowledgment about natural ecosystems (Rohmer et al., 2019). Numerous consumer groups and organizations, policymakers, and environmental advocacy groups are encouraging the adoption of sustainable concepts in business and agro-industries to limit unfavorable impacts. Nonetheless, studies carrying out on the environmental effects of this behavior, as well as how it affects energy consumption, and waste management are still lacking appropriate evaluation (Parashar et al., 2020). The environmental aspects of these studies mostly considered greenhouse gas emissions and fail to mention the influence of fundamental production systems (Rohmer et al., 2019).

Social issues like the public health perspective are also addressed by food consumption change from traditional food to organic food since this diet exposes consumers to fewer chemicals that cause human diseases. For example, there is a rising number of studies connecting health benefits with organic food consumption (Taghikhah et al., 2021). Yet, as an equivalent area, ethical food consumption also receives considerable attention, such as exploring which behavior dimensions should be emphasized to persuasively communicate and how to minimize food waste (Cozzio et al., 2020). Related to ethical food consumption, three positionings are utilized to explain consumer attitude around this behavior including local, organic, and socially sustainable. Nonetheless, studies on clarifying which positioning particularly impacts on developing ethical consumption and how to apply them for nudging this behavior are still surprisingly lacking (Cozzio et al., 2020). Eventually, although food is currently abundant, this industry still needs significant awareness to explore and apply sustainable consumption patterns (Govindan, 2018).

5.1.2. Food safety

Food safety is defined as a socio-natural process involving multiple activities finished by people who contact with distinct forms of food in different development and operation stages around the world to obtain a fixed food safety standard that satisfies both general and specific requirements (Nayak & Waterson, 2019). This concept is not only important towards SFSC but also considered as a social sustainability metric and influences environmental issues (Rodrigues et al., 2021). Yet, the previous studies on the social side of food safety showed that the lack of sufficient training, poor understanding and regard for safety standards, and the defects of complicated health protection regulations have led to food poisoning outbreaks in society (Nayak & Waterson, 2019). Furthermore, the opportunities and challenges as the world's population grow highlighted the critical role of all participants including producers, distributors, consumers, government agencies, scientists, and medical professionals to solve the issues of food safety (Fung et al, 2018). While the suggested solution for lowering incidents in food safety is by implementing corporate social responsibility policies, there are remaining worries on other impacts to risk management and its relationship with food safety (Bautista-Bernal et al., 2021).

Food safety performance is affected by food safety culture attributes, which is known as the gathering of widely accepted, shared, remained values, attitudes, and beliefs orienting for hygiene activities in particular food processing and supply network (Jia & Evans, 2021). Food safety culture is reflected through technology and management factors in an organization, combining with the workforces and the operating settings as well (Nyarugwe et al., 2020). In fact, food safety culture has become popular and received organizations' attention; however, research in this area is still limited and manufacturers are not willing to assess their culture of food safety (Nayak & Waterson, 2019). Future studies also need to examine the impact of the external environment on an organization's food safety culture by estimating the performance of firms operating in different environments of food safety management systems and national values (Nyarugwe et al., 2020).

Related to environmental issues, prior studies have explained that advanced technologies for ensuring the safety of food such as energy-saving stockpiles, smart pack, design, and novel tracking techniques help to minimize food wastages and limit trash (Parashar et al., 2020). However, there is still limited attention to climate change’s consequences on food spoilage during distribution and storage, which then lead to food unsafety (Misiou & Koutsoumanis, 2021). Tools such as good agricultural practice, hazard analysis, or total quality management are critical to managing the overall supply network, ensure food safety, and prevent negative environmental impacts while complex SCs make the traceability of products difficult. Further, there should be a discussion on the relationship between food safety standards and sustainability regulatory framework, which requires better consideration on how to make these policies compatible to promote both operational and environmental sustainability sides (Jia et al. 2018).

In the context of complicated growth in SFSC, food safety becomes significant to help stakeholders avoid risk and achieve profitability, which then requires appropriate managing and collaborating system (Parashar et al., 2020). For example, the global collaboration between participants of the food supply network is believed to ultimately guarantee food safety (Fung et al., 2018). Collaboration among participants in SC is essential to enhance traceability which assures food safety through sharing information about applied production methods and used materials, and decrease remedial expenses in case problems happen (Siems et al., 2021). Additionally, the agent-based management system and pre-warning structure are introduced as effective managing tools to support sustainability performance and food safety; yet, studies on the role of this issue towards extending improvements of SFSC are still shortcoming (Wang and Yue, 2017). In the developing trend of the 21st century, studies on food safety should exploit various management approaches including how to regularly monitor and surveil food production to increase the general public well-being and prevent foodborne illnesses.

5.1.3. Food security

The access to adequate, secure, healthy food to keep a strong and active life for everybody is ensured with the concept of food security (Mc Carthy et al., 2018). This multi-dimensional indicator consists of four main pillars. In specific, food availability links with SC activities such as production together with distribution, food accessibility characterizes the economic along with social affordability of food, food utilization appertains to safety and healthy value of the food, and food stability expresses the dynamic perspective as food security demands stability in other three pillars over time. There are some efforts that have been made to establish stable and efficient food production in order to accomplish food security (Namany et al., 2020).

However, growing population and their aspirational wants, ecosystem deterioration, soil erosion and irrigation, water and resource scarcity, decreasing cumulative yield levels, uncertain political instabilities, rising resources' consumption, climate change pose crucial obstacles for food security (Namany et al., 2019). Moreover, there is an overwhelming need for food security and expanded FSCs as a result of rapid urbanization (Gardas et al., 2018). Hence, ensuring food security has turn into the global priority and also a complicated along with demanding matter to resolve in SFSC (Kaur, 2019). Food security is greatly affected by bureaucracy degrees, policies and SC procedure in conjunction with the stakeholders' consciousness level concerning the environmental implications created by food waste. Still, extra examples and situations to investigate supplementary facets of food security such as particular stakeholders including food producers, suppliers, retailers, waste managers, policy makers and associated interest bodies are limited (Irani et al., 2018). How to enhance FSC efficiency can make fundamental improvement on food security while decrease burden on natural resources.

Attaining the actually sustainable global food security calls for a comprehensive systems-based method, rested on a policy and technological adjustment connection, approaches and outstanding practices (Mc Carthy et al., 2018). The determinants IoT assisting data recording and generation such as e-control, smart contracts, enhancement of policy, usage of radio-frequency identification are argued to be crucial enablers for a motivated food security system, food safety, and environmental sustainability (Kaur, 2019). A promising resolution for lessening the loss of food, boosting transparence, confidence of stakeholders, food security is blockchain (Kayikci et al., 2020). Additionally, studies in agricultural systems models such as avoiding equalizing food availability, integrating food accessibility indicators, evaluating stability results for food security indicators, are necessary to increase representations of food security (Nicholson et al., 2021). Developing multi-goal models for solving the contradictory decisions between environmental indicators and social indicators regarding food security from a sustainability perspective should be embedded in future studies (Nematollahi and Tajbakhsh, 2020). Further, generating tools to better understand the disconnectedness together with synergies between food networks and how they change food security impacts are needed (Cerrada-Serra et al., 2018).

5.1.4. Food waste management

Distressing concern about food waste created over a FSC is growing as it leads to adverse environmental effects such as greenhouse gas emissions, natural resources' exhaustion and pollution (Rodrigues et al., 2021). Moreover, food waste is also accountable for economic losses and food insecurity worldwide (Stancu et al., 2016). It is imperative to have greater focus on appropriate management of food waste owing to the world magnitude of such waste. Therefore, proper food waste management is indispensable in SFSC. This indicator involves choices obtainable for handling food waste upon its creation. Decreased food waste and suitable waste management lessen adverse environmental influences of food waste, conserve economic resources, and favor food security (Thyberg and Tonjes, 2016). However, developing solutions for food waste management that have the capability of utilizing the valuable resources presented by food waste is still the difficult task in SFSC.

Prior studies have addressed various issues pertaining to food waste management such as food waste management options, technologies, practices, impacts and life cycle assessment. Yet, technical and economic matters including volatile fatty acids cumulation, process uncertainty, foaming, moderate buffer capability, immense financial expense hinder full usage of food waste in anaerobic digestion systems, composting, incineration and landfilling are not fully inspected (Xu et al., 2018; Awasthi et al., 2020). Further, integration of varied actors engaging in FSC is required in sustainable food waste management in order to lessen food waste, diminish adverse environmental, social, economic effects (Özbük et al., 2020). Life cycle assessment as an effective tool for figuring out the effects of different existing practices to lessen food waste is critical for forecasting and assessing influences of future food waste policies (Omolayo et al., 2021). Moreover, circular economy solutions are demanded for favoring the closure of nutriment loss loops as well as boosting principles of recovery to increase waste materials' merit (Dora et al., 2021).

There are still some spaces for future studies with regard to food waste management. Attempt of all levels is fundamental to lessen and manage food waste which should include agricultural, industrial and environmental policies (Salihoglu et al., 2018). Further examination of how particular countries develop the building of strong food waste-to-biogas scheme including powerful procedures, possible national strategies via a comprehensive case-study regarding local environmental, social and economic situations are needed (De Clercq et al., 2017). Collaborations between academia, industry, and government are demanded for the broad anaerobic digestion application of food wastes (Xu et al., 2018). Future study is expected to test and evaluate the strength together with influences relating to various policy means as well as other interferences on practices of food waste (Schanes et al., 2018). Exploring by what means viewpoints of downstream actors across SC affect the creation of food waste together with food waste management strategies of SC actors are required (Özbük et al., 2020). Circular economy model's application via a comprehensive interdisciplinary and integrated way for fully utilizing food loss and waste in lessening waste along with recovering invaluable by-products, thus progressing towards zero waste are necessitated (Dora et al., 2021).

5.1.5. Resilience

Resilience is the system's ability to essentially remain its function, structure, and identity when absorbing disturbance or reorganize a situation (Mu et al., 2021). Firms' SC resilience strategies need to be dedicatedly aligned with competencies in order to promptly absorb, adapt, and revive their businesses after the disruption (Vanany et al., 2021). Nowadays, the rising complication of the global food network along with climate change and urbanization lead to increasing challenges to the SFSC. Therefore, this concept is completely appropriate to be employed for the food chain to ensure the recovery capability from the shock and the occurrence of unusual food safety hazards. In the SFSC, resilience plays as the capacity of a SC to forecast, recognize and protect itself against negative consequences of risks, so as to quickly return to an ordinary operating situation after a disruption (Montecchi et al., 2021). Nonetheless, while there is a thorough theoretical base of resilience, empirical studies explaining what contributes to resilience, how resilience could be improved in the stressing disturbance and times still need further attention (Coopmans et al., 2021).

The SFSC resilience after a disruption is measured by time, impact level caused by the food hazard shocks, and recovery level of the SC. The concept is argued to be enhanced through three stages including clarifying resilience context, measuring resilience, and improving resilience (Mu et al., 2021). Since various FSC risks require different types of measurements and improvement solutions, resilience context specification should be the first stage to clarify the differences and facilitate the next steps of the resilience transition. Trend analysis, systematic literature review and expert elicitation are viable methods that are applied in this step to classify the FSCs vulnerabilities and the most relevant safety hazards to the particular supply network (Banach et al., 2020). Next, resilience measurement is emphasized since it helps to integrate all three factors consisting of resistance, recovery and robustness into operationalizing practical resilience methods in multiple management circumstances. Furthermore, SC resilience composes two components being resistance and recovery. While resistance demonstrates the SC capability of preventing the shocks or instantly recovering to lessen negative effects, recovery reflects the its capability to restore to a normal or improved condition after an unwanted disruption (Lohmer et al., 2020). Thus, in the last stage, resilience improvement is able to obtain through promoting those components, such as applying food safety measurements, examining food safety shock patterns in order to quick detect of the food hazards, preparing overabundance on the production capacity, logistics and supplier network, and increasing efficient collaboration between stakeholders.

Prior studies have been implemented to enhance resilience in SFSC and reveal the SC capacity on providing quick reactions to unforeseen situations, so time is a critical measure of this concept; however, studies on time-based resilience are still shortcoming (Behzadi et al., 2018). Further, the critical role of digital applications to SCs resilience in an increasingly dynamic environment is strongly recommended. A digitalized FSC helps firms to increase the flexibility, efficiency, and reaction speed of logistical systems by controlling material flows and unforeseen dangers, in consequence, develop sustainability, and resilience throughout the SC. For example, when studies on resilience and sustainability have changed from analyzing traceability technologies to visibility systems, the adoption of novel technologies like blockchain has been encouraged to promote resilient SC through building data-driven managerial methods (Montecchi et al., 2021). Blockchain ensures SC resilience by applying the precautionary and proactive technique to decrease disruption impacts and provide multilayer safeguard for the whole supply network (Dutta et al., 2020). The recording function of this technology helps tracking mechanisms be convenient and prevent information falsification, thus, establishing necessary trusted relationships between stakeholders and then increasing network resilience (Bagloee et al., 2021). In addition, the integration of other digital technologies such as IoT, radio frequency identification or social media platforms also improves the information management systems involving dynamic information storage, information protection, and reliability (Dutta et al., 2020). Eventually, assessing the effects of connecting different analytic tools such as cloud computing, robotics, and artificial intelligence on SC resilience is also considered as a promising research trend in the future.

Furthermore, the enable of SC resilience under unwanted disruptions also need to involve the big data analytics as a data-driven method which emphasizes the critical role of swift trust and transparent information sharing (Baryannis et al., 2019). The concept helps to mitigate SC bottlenecks and uncertainties, reduce unfavorable impacts of shocks, support in SC planning and demand forecasting, build the recovery ability and adaptive capability to cope with risks in the future (Jabbour et al., 2020). Although the big data is widely known nowadays, previous studies only focused on applying structured data to research and examine the SC resilience since the amount and diversity of accessible data are still limited. The vital role and benefits of this concept on resilience have not received necessary attention, and little studies have adopted big data to analyze disaster resilience for sustainability. Moreover, empirical studies are also lacking on effectively clarifying how big data could promote SC resilience and sustainability (Jabbour et al., 2020).

5.2. Halal sustainable food supply chain

5.2.1. Halal supply chain trust

Trust deems to the firms' expectation of partners' action to bring them benefits even when they are not capable of monitoring such behavior (Ramirez et al., 2020). The Halal FSC trust is defined as the certainty of trustworthiness and integrity on food processing, handling, and safety of food healthiness towards Islamic perspectives (Kamisah et al., 2018). In practice, consumer trust in Halal food is tarnished by problems of contamination, the blend of Halal and non-Halal commodity, and various food fraud events (Rejeb et al., 2021). Contamination is a vital food standard related to religious belief; thus, the Halal food industry is easily affected when Muslim consumers recently consider food labeled as Halal are fraudulent and no longer sufficient to quality guarantee and religious criteria for consumption (Ali & Suleiman, 2018; Théolier et al., 2021). Since the food demand following Islamic principles and wholesome continues to grow, there is a need of adopting recognized food safety regulations and standards throughout FSC to ensure the trust (Kohilavani et al., 2021).

Prior studies have demonstrated trust as a critical indicator for productive collaboration and supply network integration performance, and increase sustainable SC (Ramirez et al., 2020). For instance, in sourcing activities, trust among participants is found to help to promote SC agility through enhancing internal cooperation, information sharing, and integrating suppliers into mutual development programs. It is argued that the higher SC trust pursuing Halal perspective is able to prevent the business relationships violation and ensure stakeholders complete the anticipated tasks (Ali & Suleiman, 2018). Furthermore, trust also reflects the firm's ability to forecast market demand, resulting in satisfy consumer expectations and prevent danger to the users. However, an original mechanism to guarantee the “Halalness” of products like the Halal logo recently lost the Muslim consumers' trust by numerous food fraud cases (Théolier et al., 2021). Thus, increasing traceability and visibility by adopting appropriate methods are urgently required to enhance trust among stakeholders (Liu et al., 2021).

Although trust benefits the whole halal SFSC by generating advancements and enhancing relationships among participants, the studies on information and communication technology applied in building trust are still lacking (Liu et al., 2021). There are only little studies or methods applied to test the trust of Halal SFSC entirely, especially, when customers have high priority in sustaining Halal food integrity (Kamisah et al., 2018). So, there is a need for studies in adopting technically advanced applications, such as IoT technology to ensure the halal SFSC authentication to increase consumer's confidence in halal food products which strictly comply with ethical and Islamic guidelines (Rejeb et al., 2021). Empirical studies should focus on the use of IoT-enabled equipment to increase the controlling capability and clarify the related procedure of handling, storing, and transporting foods; furthermore, the transparency and SC fault tolerance should be exploited on problems arising when untrusted factors are involved in the food chains, which does not comply the halal standards.

5.2.2. Halal certification

Certificates and labelling are necessitated to demonstrate to consumers that products are complied with Halal production and SC network (Arsil et al., 2018). Halal certification indicates the authorized recognition of preparing, slaughtering, cleansing, handling, processing, storing, transporting and distributing by the established organization (Rejeb et al., 2021). With Halal certification and labeling, firms guarantee that their products are suitable for Muslims' consumption regarding quality, assurance, cleanness (Suryawan et al., 2019; Khan et al., 2019a). Such certification generates trust as well as assures consumers of their selection (Jia and Chaozhi, 2021). Halal certification is now turning into a branding strategy among firms. Certainly, the indicator imposing the conformity of firms with numerous requirements is indispensable for securing sustainable competitiveness in progressively fierce competition as well as to convince firms' stakeholders (Ali and Suleiman, 2018; Salindal, 2019). Moreover, Halal certification employed for inducing transparency of Halal manufacturing is crucial for expanding business (Khan et al., 2019b).

The readiness to pay of consumers is definitely associated with need of Halal logistics certification (Khan et al., 2019a). Muslim consumers are fully influenced by the presence of Halal certification and labeling (Ahmadova and Aliyev, 2020). Countries with particular criteria, processes for issuing Halal certificates have created standardization lacking and decreased the perceived legitimacy of Halal certificate; therefore, generating a global specification and introducing one global Halal logo are needed. However, quantitative and empirical studies to test incentive and hindrance elements in real Halal industry are still absent (Talib, 2017). Driving elements such as consumer demand, safety and quality, rule of government, management commitment; impediment elements comprise implementation cost, shortage of assistance from government, some regarding human resource and economic viewpoint should be more emphasized.

Halal certification should be executed as a fundamental feature concerning business strategy in both internal firm and exterior SC as it is argued to enhance innovative along with business accomplishment (Salindal, 2019). Internal incentives of Halal certification appertain to procedures, people, obtainable resources within firm; external incentives include government interference, market force. On one hand, from adopting Halal certification, firm can enjoy internal advantages such as enhanced product quality, financial performance improvement or enjoy better marketing and market shares expansion as external advantages (Talib, 2017). On the other hand, comprehensive aid from government with robust commitment from management is needed for adopting Halal certification. Still, determined obstacles to such adoption in real circumstances are missing (Khan et al., 2019b). The way Halal certification hinders or promotes efforts of firms together with industry for maintaining Halal stability is demanded (Ali and Suleiman, 2018). Future study should examine the interaction between influential market actors and Halal requirements, whether such actors purely adopt or energetically make effort to form the criteria in Halal standards to satisfy their concerns (Suryawan et al., 2019). Further, information technologies such as IoT, blockchain, providing key advantages for Halal SFSC like products' traceability, SC efficiencies' improvement, livestock management facilitation, foods' Halal status authentication and Halal certifications' monitoring should be noticed (Rejeb et al., 2021; Ali et al., 2021).

5.2.3. Islamic values

Islamic values pertain to the notion of desirable virtues or characteristics founded on Islamic sources have considerable effect on Muslims' culture, living manners, consumption attitudes (Wahab et al., 2016). With the intention of practicing such religious standards, Muslims consume Halal food produced with ingredients and producing procedures are in conformity with Islamic values (Lim et al., 2020). Consumers feels and evaluates that food conforms to Islamic values, their attitude favors that food (Suhartanto et al., 2019). Further, Islamic values play a notable role in the way Halal food production must be implemented in SC. For example, Halal branding constrains the religious principles to design brands of universal appeal to Muslim consumers (Hosain, 2021).

Prior studies focused on both demand side and supply side relating to Islamic values' contribution on Halal SFSC such as the impact of religion on consumer intention, behavior, attitude as well as on production and marketing. From the demand side, Islamic religion has a certain impact on consumers' attitude, intention, behavior, satisfaction and loyalty to Halal food. To be specific, religious faiths are the most crucial element bringing about the consciousness and purchasing intention of Halal food. Hence, stimulating consumers with religious activities is decisive for the achievement of marketing Halal products such as promoting religious events, assigning corporate social responsibility for religious activities, building relations with religious bodies (Nurhayati and Hendar, 2019). Muslims prefer food with religious touch and being certified by reliable Halal food certification agency (Ali et al., 2020). Future study should concentrate on the elements of Halal purchase intention along with culture and religious identity's role of Muslim consumers.

From the supply side, meeting the Islamic religious requirements demand firms to care for manufacturing processes in order to secure the food purity, quality and assurance in Halal SC (Wilkins et al., 2019). Halal concept embraces products as well as services with the utmost quality fulfilling accelerating demand of SFSC. Hygienic procedure, food safety, ecologically friendly, animal welfare are most apparently determinants related to Islamic principles together with manufacturing to encourage agriculture towards sustainability (Rezai et al., 2015). Halal labelled goods' manufacturing facilitates sustainability matters in operations as it is designed on the principle of removing hazardous elements to human health along with ecosystem. Together with animal welfare, Islamic values forbid adoption of immoral manufacturing processes weakening people health, environment; demand firms to cater improved working surroundings, minimum salary, better environmental along with social principles to employees (Haleem et al., 2020). Further, Islamic values request execution of fair-trade practices to assist small manufacturers and encourage sustainable living by offering fair prices (Khan et al., 2018). Firms are expected to approach more Muslim consumers in case firms appropriately prolong Islamic values-compliance founded on a consolidated agreed principle by relying production, stimulation strategies, working rules, employees together with business schedule demands (Hosain, 2021). Also, verifying whether the link between religion and food benefits corporate social responsibility are needed (Secinaro and Calandra, 2020).

5.2.4. Halal food safety

Along with the non-Halal food, the Halal SFSC also shows essential concerns on the food safety. The requirement for ensuring food safety is strongly placed on Halal enterprises under the complicated development of Halal FSC, especially when now both the Muslim and non-Muslim customers have expandingly chosen Halal food (Rejeb et al., 2021). Food safety in Halal FSC is acknowledged as the existing safety standards following Halal assurance system which focus on preventing the consumer's health hazards (Khan et al., 2018). As Islamic values appreciate the good deeds and ethical conduct, it is also closely engaged to concerns of food safety in SC (Izberk-Bilgin & Nakata, 2016). Thus, halal food production criteria are required to guarantee the wholesomeness, hygiene and safety throughout the whole supply.

Prior studies emphasized the combination of food safety and halal criteria in SFSC. Nonetheless, many domains are calling for further studies such as the perception of non-Muslim communities and producers on a Halal standard system, how manufacturers and governments ensure food safety in Halal markets, and the way Muslim governments clarify and deal with food safety along with Halal matters. In addition, the promising employment and execution of Islamic dietary norms in compliance with food safety, notably concerning current demands for practicability requested by food manufacturers were explored. As a result, a safe Halal SFSC presenting the value of integrating safety and Halal strengthens food producers, assures better proceeding of key rules that are instantly put into practice. Additionally, advanced technologies are recognized as being able to prevent risks and promote Halal food safety by enhancing traceability and transparency in the Halal SFSC (Ali et al., 2021). With the occurrence of novel techniques, Muslim consumers have the assurance that Halal products are clean and hygienical under Halal principles, throughout the process from the raw materials to their hands (Kohilavani et al., 2021). This united system brings advantages to producers, monitoring departments, and increases consumers' trust referring to strict principles and sustainable systems in FSCs.

6. Concluding remarks

The topic of SFSC has received more attention in both non-Halal and Halal context under the sustainability pressures; yet, the solution to promote this concept has not been fully explored. To fulfill this gap, the current study is proceeded exploiting a data-driven approach to display and compare indicators for non-Halal and Halal SFSC based on the literature review; then, recommend the highlighted issue for studies in the future. In this study, two sets of publications in non-Halal and Halal SFSC are analyzed through VOSviewer; accordingly, 178 original keywords are defined. These keywords are analyzed through two rounds of FDM to finalize a set of 25 critical indicators. FDEMATEL method is adopted to indicate indicators having the highest effect level including food consumption, food safety, food security, resilience, waste management in non-Halal SFSC, and Halal trust SC, Halal certification, food safety, Islamic values in Halal SFSC.

This study reinforces the literature of Non-Halal and Halal SFSC and offer guidance for succeeding studies together with practical attainment. Regarding SFSC, most significant indicators are food consumption, food safety, food security, resilience and food waste management. Concerning Halal SFSC, most crucial indicators consist of food safety, halal certification, halal SC trust and Islamic values. This study supports firms to make better decisions on taking advantage of most significant indicators to affect the remaining indicators with a view to achieving SFSC and Halal SFSC as well as satisfying Muslim as well as non-Muslim consumers. Further, both professionals together with practitioners can make the most of these outcomes for forthcoming interrogation in the field of SFSC and Halal SFSC. The knowledge gaps and outlooks for coming study are as follows:

First, related to food consumption in SFSC, further explanation should focus on the variety of food usage between urban areas. Additionally, appropriate examination of food consumption effect on environment, along with precise determination of which dimension among local, organic, and social sustainability has the highest driving power on ethical food consumption are still at the early stage.

Second, in the topic of food safety, the external context of food safety culture should be clarified as well as the role of this concept on SFSC. In addition, the sustainability regulatory framework needs to be adjusted to conform to food safety standards, which calls for further discussions. Under Halal perspective, food safety in SFSC is also an imperative matter which demands more studies including the perception of not only non-Muslim consumers but also producers on halal regulations, and how governments deal with food safety towards Islamic values.

Third, future studies should concentrate on extra examples, situations to interrogate more facets of food security such as indicating exact stakeholders. Developing multi-goal models in sustainable agricultural SCs aiming to deal with contrary decisions between environmental indicators such as water, land use and social indicators concerning food security from sustainability viewpoint is needed. Generating tools to better catch the disconnectedness, synergies between food networks and how they alter food security effects call for further studies.

Fourth, further investigation of the way particular countries develops the building of strong food waste-to-biogas scheme including powerful procedures, viable national strategies with reference to local environmental, social and economic circumstances are required. The strength as well as impacts of varied policy means along with other interferences on practices of food waste, food waste management strategies of SC actors and by what means attitudes of downstream actors across the SC affect food waste formation need more exploration. Future study should inspect circular economy model's execution via a complete interdisciplinary and integrated approach for entirely taking advantage of food waste.

Fifth, concerning on resilience in SFSC, further empirical studies and researches on integrating blockchain with other novel technologies are needed to enhance this concept. In addition, time-based resilience also requires more attention.

Sixth, only a few studies examine methodologies using to evaluate Halal SFSC trust. Further studies on advanced techniques are necessary to guarantee authentication and consumer's trust of Halal SFSC.

Seventh, quantitative and empirical studies to test enablers and impediments to Halal certification adoption in real circumstances are still lacking. Future study should explore the interaction between influential market actors and Halal requirements, whether such actors purely employ or actively endeavor to form the criteria in Halal standards to please their concerns. Further, IoT and blockchain providing key benefits to Halal SFSC, including for Halal certification procedure should be noticed.

Last, Islamic values affect both demand side and supply side in halal SFSC. Hence, future study should focus attention to the elements of Halal purchase intention along with culture and religious identity's role of Muslim consumers. Further, authenticating whether the connection between religion and food is beneficial to corporate social responsibility are necessitated.

However, some limitations exist in this study. First, this study employed Scopus database which also comprises low impact sources regardless of its broad scope. Hence, using alternative databases or encompassing assorted sources to generalize results should be considered in future study. Second, purely articles together with review papers were exploited in review procedure, thus, upcoming studies can include more pertinent books for broadening data range. Finally, 30 experts were approached which may provoke the nonobjectivity for analysis owing to their knowledge, experience and involvement in the studying field. Consequently, adding more respondents is advised to inhibit such issue in future study.

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APPENDIX A. Respondents' demographic for FDM result (non-Halal SFSC)

Expert	Position	Education levels	Years of experience	Organization type (academia/practice)
1	Manager	PhD	20	Practice
2	Professional	Master	15	Practice
3	Professional	Master	12	Practice
4	Professional	Master	12	Practice
5	Professional	Master	12	Practice
6	Professional	Master	20	Practice
7	Professional	Bachelor	15	Practice
8	Professional	Bachelor	12	Practice
9	Researcher	PhD	13	Academia
10	Researcher	PhD	10	Academia
11	Researcher	PhD	10	Academia
12	Researcher	Master	16	Academia
13	Researcher	Master	12	Academia
14	Researcher	Master	12	Academia
15	Researcher	Master	10	Academia

APPENDIX B. Respondents' demographic for FDM result (Halal SFSC)

Expert	Position	Education levels	Years of experience	Organization type (academia/practice)
1	Manager	Master	19	Practice
2	Manager	Master	16	Practice
3	Professional	Master	13	Practice
4	Professional	Master	12	Practice
5	Professional	Bachelor	11	Practice
6	Professional	Bachelor	10	Practice
7	Professional	Bachelor	10	Practice
8	Researcher	PhD	17	Academia
9	Researcher	PhD	16	Academia
10	Researcher	PhD	16	Academia
11	Researcher	PhD	15	Academia
12	Researcher	Master	14	Academia
13	Researcher	Master	11	Academia
14	Researcher	Master	10	Academia
15	Researcher	Master	10	Academia