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Safety Failure Factors Affecting Dairy Supply Chain: Insights from a Developing Economy

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Abstract: Safety issues in the dairy industry have attracted greater attention in recent years, and the public have showed an intensive concern regarding safety failure in the dairy supply chain. Since the dairy industry is closely associated with humans and fulfills basic necessities, it is necessary to explore safety failure factors (SFFs) affecting the supply chain of the dairy industry. This paper aims to explore the SFFs of the dairy supply chain using an interpretive structural modeling technique (ISM) and Matrice d'Impacts Croises Multiplication Appliques a un Classement (MICMAC) analysis in a Pakistani context. A total of twenty-five failure factors have been identified through literature reviews and the opinion of an expert team, including managerial and technical experts from the dairy industry, as well as academics. Interpretive structural modeling (ISM) is applied to analyze the mutual interaction among barriers and to develop a structural model. The MICMAC technique is used to identify the importance of SFFs based on their driving and dependence power. The results of this study will help decision-makers in the dairy industry to plan their supply chain activities more effectively and efficiently by managing the identified barriers.

Keywords: dairy industry; supply chain management; safety failure factors; interpretive structural modeling; MICMAC analysis

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1. Introduction

Effective supply chain management seems to be a crucial concern in today's intensifying competitive business environment, and it has to be dealt with in a global business context [1]. Information and communication technology developments are essential tools for an effective supply chain. A supply chain is the chain of different activities involved in converting raw material into a final product to fulfill customers' needs [1]. By viewing it in this way, the supply chain can be improved competently.

In recent years, most researchers of supply chain networks have been focused on agri-business theory [2]. Dairy products have shaped the diets of many populations across the world [3]. Sustainability plays an important role in the dairy supply chain, minimizing unit production cost while adding flexibility to products or processes. Sustainability and efficiency can be attained through supply chain collaboration, innovation, mitigation of uncertainties, and lean and green initiatives [4–8]. Technology can also be beneficial to exploring the plausible future of the food supply chain. Moreover, competitiveness leads industries towards sustainability [9].

To compete globally and develop sustainable agri-products, the safety standards of dairy products are crucial. Increased competitiveness in dairy industry development is

necessary in order to meet the safety standards by prioritizing some crucial actors, including technological transfer, research and development (R&D), trade policies, and social and political agendas [10]. However, SFFs in the dairy industry have been reported extensively in different contexts [11,12]. To improve the regulatory system of food safety in the dairy sector, many countries have formed strict regulations and established institutions [13].

Due to the investment price capping policy in Pakistan, the requirements of local demand for milk cannot be fulfilled. In 2016–2017, Pakistan imported milk and cream with the value of USD 234 million, despite the fact that the country is the fifth largest producer of milk in the world. Dairy contributes 11% to the GDP of Pakistan. In a conducive environment, this industry would have the potential to become an economic powerhouse in the country. Almost 44% of children under the age of 5 years are stunted, and almost 15% are starving. This is a national concern, and should be acknowledged by the government in order to support the dairy sector in producing quality and safe milk, and to make the milk available for every household of the country. Some other main reasons for the low animal production include the low genomic potential of cows, the lack of forage resources, the conservation of outmoded farming methods and the chaotic marketing system. Therefore, the quantification of livestock in the context of economic growth is necessary because many policymakers can use this information to identify the potential impact on the economy of dairy farms, and their benefits related to industries and societies. A lack of technological innovation, inventory management and supplier management are the major issues in developing countries, including Pakistan, contributing to dairy safety failures. Most previous researchers have not stressed the SFFs affecting the supply chain process of the dairy industry in Pakistan. Therefore, it is important to identify those factors, trends and drivers to achieve the desired outcomes.

In light of previous studies, this study focuses on the SFFs of the dairy supply chain. This study may also prove to be useful for dairy industry in Pakistan as regards accomplishing efficient and sustainable supply chain practices, and also might represent an important addition to the supply chain literature. This study used a widely used methodology named interpretive structural modeling (ISM) to analyze the SFFs of the dairy supply chain, which could help prioritize important factors that might need to be addressed for the improvement of the dairy supply chain. The ISM approach has been used to identify the complex relationship between different elements, and a supporting methodology, MICMAC, is adopted to illustrate the driving and dependence powers of each element. Further information about ISM and MICMAC are given in the methodology section.

This study contributes both theoretically and practically. Theoretically, this study contributes to the safety literature in the dairy supply chain context of developing countries, especially in Pakistan. This is the first study to identify SFFs in the dairy supply chain. The use of ISM and MICMAC for analyzing SFFs also makes the study novel. Further, the dairy supply chain has also been affected by safety issues in the Pakistani context due to diseases emerging in the COVID-19 scenario. Therefore, the dairy supply chain requires more attention from researchers.

The rest of the paper is structured as follows: Section 2 describes the Literature Review, Section 3 consists of methodology, Section 4 included results and discussion and Section 5 presents the conclusion.

2. Literature Review

2.1. SFFs in Dairy Supply Chain

In recent years, technological innovation, inventory management and supplier management have been the main determinants of quality in the dairy industry [14]. Different developed countries, such as the UK, the US and Australia, have been able to improve their dairy supply chain practices and overcame critical barriers given their plentiful resources [15–17]. However, developing countries are yet to achieve these critical factors. For success in the food supply chain, and to improve the performance of an organization, it is necessary to identify and highlight the critical success factors (CSFs) [18].

Many studies have identified SFFs in the supply chain of the dairy sector. Perron [19] examined four categories of barriers that impede the adoption of supply chain safety measures in SMEs, including attitudinal and perception barriers, information barriers, resource barriers and technical barriers. Ref. [20] described the market challenges and potential losses related to the cold chain in the frozen food industry in the Indian retail sector. The author states that, when considering the end consumers' knowledge, behavior and preferences in food, some key challenges arise regarding unpacking, knowledge optimization strategies and lack of effectiveness in food supply chain. Chandrasekaran and Raghuram [21] analyzed different enablers of risk management in the dairy sector and found that there are a lot of risks in both the dairy farming industry and the dairy processing industry.

There are different uncertainties at different levels of supply chain management in the dairy industry [22]; therefore, a sustainable framework is needed to promote green practices in the manufacturing industry [23]. Kumar and Staal [24] outlined that farmers are not being educated appropriately as advanced methods are being used in modern milk supply chains. The relocation of dairies from regions rich in water resources to regions with limited resources is likely to be shortsighted. Pant and Prakash [25] found that the quality control system in the dairy production process in developing countries is one of the main SFFs in dairy supply chains. Berem and Obare [26] found that the illegal and improper distribution of milk is one of the main causes of lower productivity. Buzby and Hyman [27] identified that food wastage must be stopped as the world is facing a serious issue of food shortage. Lemma and Kitaw [28] proposed the modeling and optimization approaches used in the perishable food supply chain literature. Park and Kim [13] used coding to systematically analyze food safety incidents, and concluded at which point the breakdown in food safety is likely to occur.

Due to the high focus of the supply chain on productivity, on-time delivery and better order filling rates, competition is higher in the food processing sector [6]. External barriers are more impactful than internal barriers, as external barriers include poor regulations, poor supplier commitment and industry-specific barriers, whereas internal barriers include cost and legitimacy [29]. Hemme and Otte [30] described a lack of supervision from relevant authorities in the dairy sector. Many SMEs see the adoption of environmental testing as a cause of high financial cost to the business, which could not be passed on to the end user. Finally, the study found that the government can play an important role in this scenario by improving awareness.

Worldwide, many studies have suggested different techniques and methods to reduce the SFFs in the supply chain of the dairy sector. Chalupkova [31] suggested that appropriate decision-making, following environmental testing standards and regulations, can improve the safety in supply chains. It is necessary and possible to improve productivity and develop the dairy chain using proper indicators [32]. Lemma and Kitaw [28] proposed modeling and optimization approaches that focused on the perishable food supply chain literature, as well as waste and loss assessment in food supply chains. For assessing the adequacy of various innovations in dairy supply chain practices, Ali and Lynch [33] applied the Q-methodology to identify the patterns of low-input and organic dairy supply chain members in four European countries. Kumar [34] described a conceptual model of dairy supply chains, and determined the importance of a novel conceptual model for supply chain performance measurement. Prakash and Pant [35] stated that the balance score card (BSC) approach can be used to measure the safety performance of the dairy supply chain.

Developing countries, including India, that are facing the same problems in the dairy sector have launched dairy processing cooperatives programs in order to improve smallholder dairy products (FAO 2010). Kumar and Kumar [36] suggested that milk procurement potential may be determined using Geographical Information Systems (GISs), and stated that the analytical application of GIS, such as in proximity analysis, is very useful in various business decisions, such as identifying new villages to be used as procurement centers. However, a productive technique for dairy quality control requires systematic

risk analysis, which should be based on comprehensive studies from "farm to fork". A questionnaire-based survey was conducted to rank the identified SFFs in the Indian context [37,38].

Based on the literature mentioned in Section 2.1, it is also necessary to summarize the dairy industry of Pakistan and outline the aims of the current study in the Pakistani dairy supply chain context.

2.2. Dairy Industry of Pakistan

Agriculture is the lifeline of Pakistan's economy, and livestock plays a vital role by providing items that are essential to human diets [39]. It contributes 18.9% to the GDP, and consumes 42.3% of the labor force [40]. Pakistan is one of the largest milk producers in the world; nevertheless, only about 3% of it is processed for value addition, while a major sectioned is consumed locally through traditional marketing systems. According to a commission [40], milk production during 2018–2019 was 59,759 tons, which is high compared to the previous year's total of 57,890 tons.

The dairy industry has shaped millions of dairy farmers' lives in Pakistan. The contribution of livestock in the agriculture sector is about 58.92%, and its contribution to GDP growth remains at 0.43% percent, with a share in national GDP of 11.1% (Pakistan Annual Plan 2017–2018). During 2018–2019, the livestock sector grew by 4.00%, and its gross value addition amounted to INR 1430 billion [40]. Pakistan earned USD 528.212 million as foreign exchange through livestock export and allied products during July–March of 2018–2019 [41].

According to Bar [42], in the UNDP's latest survey (September 2018), Pakistan stands at 150th place in the human development index, among 189 countries. Pakistan has the sixth largest population in the world, with approximately 212.242 million occupants, of which 49.08% live in villages (NIPS, Pakistan Demographic and Health Survey 2017–2018). Pakistan's economy is the second biggest economy in the South Asian region, valued at USD 305,000 (The U.S. Central Intelligence Agency, 2017), and Punjab is one of the biggest provinces in terms of dairy milk production in Pakistan, as it produces three-fourths of its total milk. Punjab is also one of the largest milk districts in Asia, with 15 private companies competing to collect farmers' milk for processing, including global giants Nestle, Haleeb foods and Halla. Its per capita production is improving in terms of the number of dairy cows, rather than any increases in milk production.

Based on these above two sub-sections, it has been found that literature on SFFs in the dairy supply chain is scarce, and most of the previous studies have ignored this serious issue. The literature also indicates that earlier studies analyzing SFFs were not carried out via a sound and systematic methodology, such as ISM or MICMAC. Therefore, this study is novel, adding value to the safety literature by evaluating SFFs via the ISM and MICMAC methodologies.

2.3. Study Objective

After a comprehensive literature review, it was found that studies on the dairy industry are limited, and have not concentrated on SFFs in the dairy supply chain, especially in the Pakistani context. Moreover, existing studies focus on supporting the farmers and linking them up with urban markets. However, no study has yet identified major SFFs in the Pakistani dairy supply chain. Therefore, the aim of this study is:

- ➢ To address the SFFs in the supply chain of the dairy industry in Pakistan;
- ➢ To establish the interaction among SFFs in the dairy industry using the ISM technique, and classify the barriers through MICMAC analysis;
- ➢ To propose policy recommendations based on the severity of factors.

3. Research Methodology

The methodology of this research has two main components. In the first part, a detailed literature review derived the key factors of safety failures. In the second, the relevant SFFs

were selected for further analysis. After that, the ISM and MICMAC approaches were used to examine the expert opinions through brainstorming sessions. ISM is a methodical and interactive technique that depends on a group of independent professionals and that helps in understanding the interrelationships among variables. ISM and MICMAC analyses also help in addressing the binary relationships among the described factors. However, the relationships among these factors vary; some relations are strong, some of them are normal, and some may be weak [43,44]. In this sense, ISM analysis works as a communicative tool to understand and explain the complex interrelated relationships among factors [45]. Moreover, the experts selected in our study are highly skilled in decision-making and applying ISM techniques. Additionally, the combined use of ISM and MICMAC analyses make this study simpler for readers/managers to understand, and thus use to manage sustainability initiatives in supply chains in the Pakistani context, as well as in other developing countries (with marginal modifications).

All steps of the methodology, along with its goals and output, are explained in Figure 1.

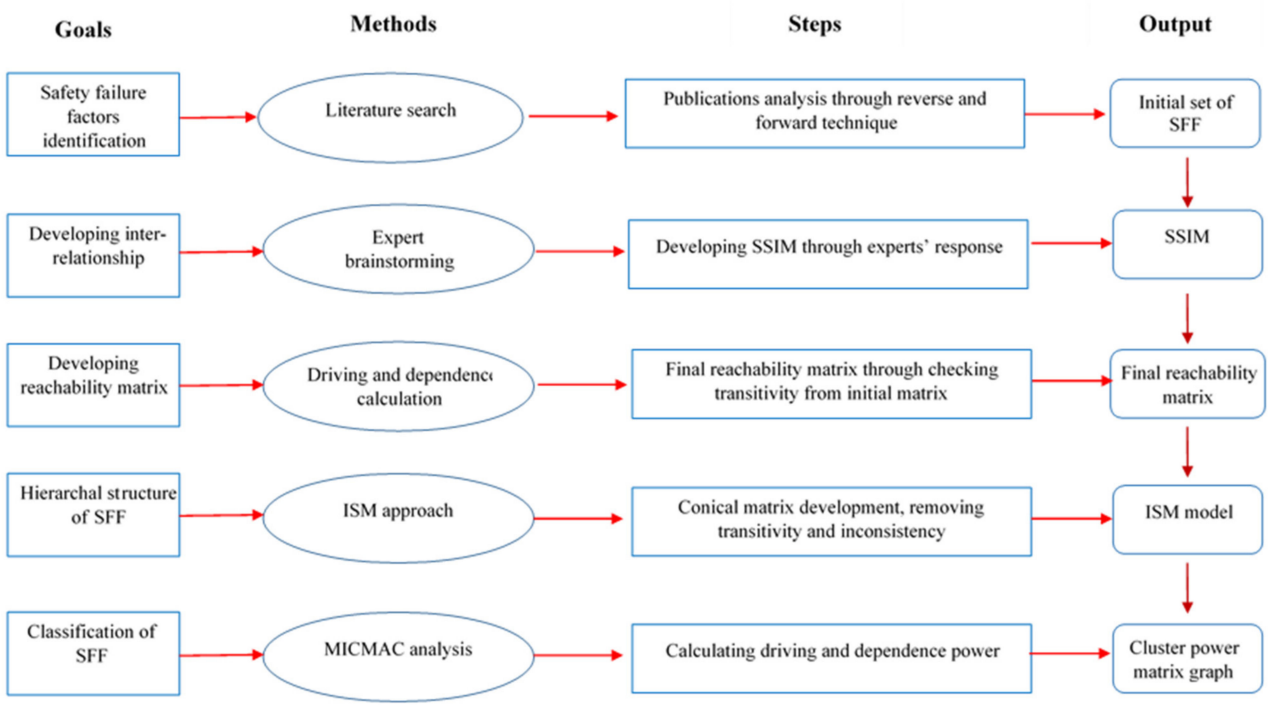

Figure 1. Detailed methodological approach to identifying SFFs in the dairy supply chain.

3.1. SFFs Identification through Extensive Literature Review

To identify the factors in the dairy industry in Pakistan, an extensive literature review was performed with the help of many research articles. Those research articles were found through different databases, including Science Direct, Springer, Emerald, Taylor and Francis, JSTOR, PubMed and Google Scholar. The keywords used to find the related articles are shown in Table 1. Significant keywords were identified in the literature, but their sub-keywords, such as milk delivery, transport and storage, were not considered in this novel study.

Table 1. Literature search criteria.

Keywords	"Dairy industry" OR "Critical issues" OR "Supply chain safety issues" OR "Safety barriers" OR "Dairy Industry issues" OR "Disaster of Risk" OR "Dairy production" OR "Dairy Farming" OR "Dairy product safety failures" OR "Milk production" OR "Dairy Policies" OR "Dairy industry downfall" OR "Dairy industry barriers"
Exclusion criteria	Articles that have only title, author name, keywords, and abstract. A paper that does not feature a review, surveys, different sound methodologies, strong discussion, or dairy issues criteria

Initially, 150 articles were analyzed. Later on, using the evaluation criteria shown in Table 1, 70 articles from 30 journals were identified. After examining the contents and abstracts of these articles, irrelevant articles and journals were removed. Finally, 30 articles from 21 journals remained, with the addition of four conferences. Some of the more popular journals are *Nature*, *World Applied Sciences Journal*, *Journal of Social, Behavioral and Health Sciences*, *Journal of Cleaner Production*, *Journal of Management Sciences and Technology*, *International Journal of Scientific and Engineering Research*, *Journal of Business Management*, *Journal of Dairy Sciences*, *Journal of Applied Economic Sciences*, *Indian Journal of Agricultural Economics*, *Journal of Clinical Oncology*, *Journal of Industrial Engineering and Management*, *Journal of Advanced Operations Management*, *Journal of Basic and Applied Scientific Research*, *Journal of Productivity and Performance Management*, *International Journal of Services and Operations Management*, *British Food Journal*, *International Journal of Environmental Studies* and *Journal of Building Engineering*.

The identified factors are explained in Table 2.

Table 2. Significant SFFs in the supply chain of the dairy industry.

No.	Safety Failure Factors
A1	Poor quality control in production process
A2	Employees are the carriers of some diseases and chances of transfer to dairy
A3	Illness of employees
A4	No clinical examination of employees before being officially employed
A5	Inadequate cold storage facility during mobility of dairy food
A6	Unhygienic and unsafe transportation of dairy food
A7	Inappropriate company location
A8	Lack of qualified storehouse
A9	Unsafe milk from the dairy station
A10	Bad health conditions of farmers
A11	Unqualified animals' food and veterinary drugs
A12	Companies purchase unsafe dairy food
A13	Invalid sampling
A14	Non-standardized packaging
A15	Companies sell unsafe dairy products
A16	Improper management
A17	No compliance with the rules and regulations
A18	Farmers are not equipped with the latest farming technology
A19	Lack of feedback mechanism
A20	Illegal supply of raw milk
A21	Wholesalers and retailers promote unsafe dairy food
A22	Unqualified system of milk collection and delayed delivery
A23	Unhealthy cows
A24	Lack of environmental testing by EPA
A25	Lack of supervision by relevant authorities

3.2. Interpretive Structural Modeling (ISM)

The interpretive structural modeling (ISM) technique was established and presented by Warfield in 1973, and its roots are in graph theory. The ISM technique is mainly proposed as an interactive learning process, which collects a set of different but directly related variables into an inclusive systematic model. ISM is a systematic approach, and it gives a structure to the complex relationship among variables. Refs. [46–49] stated that ISM transforms erroneous and unclear models into precise and visible models. Different studies employing ISM and MICMAC techniques are listed in Table 3.

Table 3. Earlier related studies using ISM.

References	Objective	Country	Methodology
[14]	To bring out the barriers in the dairy supply chain and establish the interaction among barriers in the dairy industry.	India	ISM and MICMAC methodology
[50]	To investigate the effects of the barriers and benefits on the e-procurement adoption decisions.	Turkey	ISM and SEM approaches
[51]	To analyze the barriers in green supply chain management.	India	ISM and MICMAC techniques
	To examine the determinants that influences the growth of Indian SMEs in the food industry and to identify the most important variables affecting growth.	India	ISM and SEM approaches
[52]	To identify the factors influencing consumers' decisions when buying beef products and consumers' information from twitter in the form of big data.	India	ISM and Fuzzy MICMAC techniques
[53]	To investigate the technical barriers in the dairy industry in context of Saudi Arabia.	Saudi Arabia	ISM methodology

The ISM–MICMAC approach has been employed in this study to identify the safety failure factors that impact the dairy supply chains of developing countries, especially Pakistan. This approach is used to draw a contextual relationship among different SSFs. It helps to demonstrate the relationships of different elements in the hierarchical structure [54]. However, various MCDM methods can perform the same analysis, e.g., data mining, TOPSIS, game theory, analytical hierarchy processing (AHP) and Bayesian theory. The comparison of these approaches with [48,55–58] is given in Table 4. Raj and Shankar [59] defined some attractive features of the ISM technique, which are given below:

- The ISM interprets the expert's judgement regarding various factors' relationships;
- ISM is a hierarchical structure-based model that justifies the connection of various complex factors;
- This approach helps to show the hierarchical structure of different factors in a diagraph model;
- ISM works on the philosophy of group decision-making (expert opinion), but it is also useful for individual responses.

Table 4. Comparison of ISM–MICMAC with other methodologies.

ISM-MICMAC	Data Mining	TOPSIS	Game Theory	AHP	Bayesian Theory
This technique assists in identifying the interrelations between variables on the bases of their driving and dependence powers.	In this approach, firms try to convert their raw data into useful information through software.	This technique is used to compare alternatives through the identification of their weight criteria for the best possible solution.	In this mathematical approach, different strategies are employed in competitive situations in which respondents' actions are related to the actions of other respondents.	This mathematical approach is applied in the pairwise comparison between variables.	Bayesian theory is used to examine conditional probability through the interpretation of mathematical formulas.

Raj and Rifkin [60] described the characteristics of ISM as follows:

i. This methodology is interpretive, as the opinions of the experts describe why and how dissimilar variables are related;
ii. It is structural, as on the basis of the relationship, a structure is extracted from a complex set of variables;
iii. It is a modeling approach, as the specific relationships and overall structure are illustrated in a diagraph;
iv. It is mainly proposed as a group learning process, but individuals can also use it;
v. It helps to impose the directions and orders on the complex contextual relations among elements of the system.

Despite the advantages of ISM, it has some limitations. The relationships of different variables rely on experts' experience. Hence, the experts' bias during the observation of variables could affect the final model. Moreover, ISM does not apply any weight to the variables either [61]. Karamat and Shurong [62] described the different steps of ISM as follows:

1. Variables affecting the system are listed at first;
2. Secondly, relationships are established among the listed variables to classify which pairs should be examined;
3. The next step is to establish a structural self-interaction matrix (SSIM), which identifies pair-wise relationships among those variables;
4. In this step, the initial reachability matrix is developed to check the transitivity of variables in the binary form;
5. The partition of the initial reachability matrix over different levels is done in this step, and the final reachability matrix is obtained as a result;
6. A diagraph is drawn using the contextual relationships given in the final reachability matrix;
7. The transitive links are mitigated in this step by replacing the variable nodes with problematic elements;
8. The ISM model is to be reviewed in the last step to check the inconsistency, and then necessary modifications are made for improvement.

The above-mentioned steps of the ISM methodology are illustrated in Figure 2.

3.2.1. Application of Interpretive Structural Modeling

Structural Self-Interaction Matrix (SSIM)

A structural self-interaction matrix (SSIM) is obtained from the interactions among the described factors. The existence of a relation between any two factors (i, j) and the associated direction of said relation is questioned. After finding the SFFs in the dairy industry of Pakistan, the contextual relationships among these factors are determined via a discussion amongst experts (developers, academicians, dairy companies and farms).

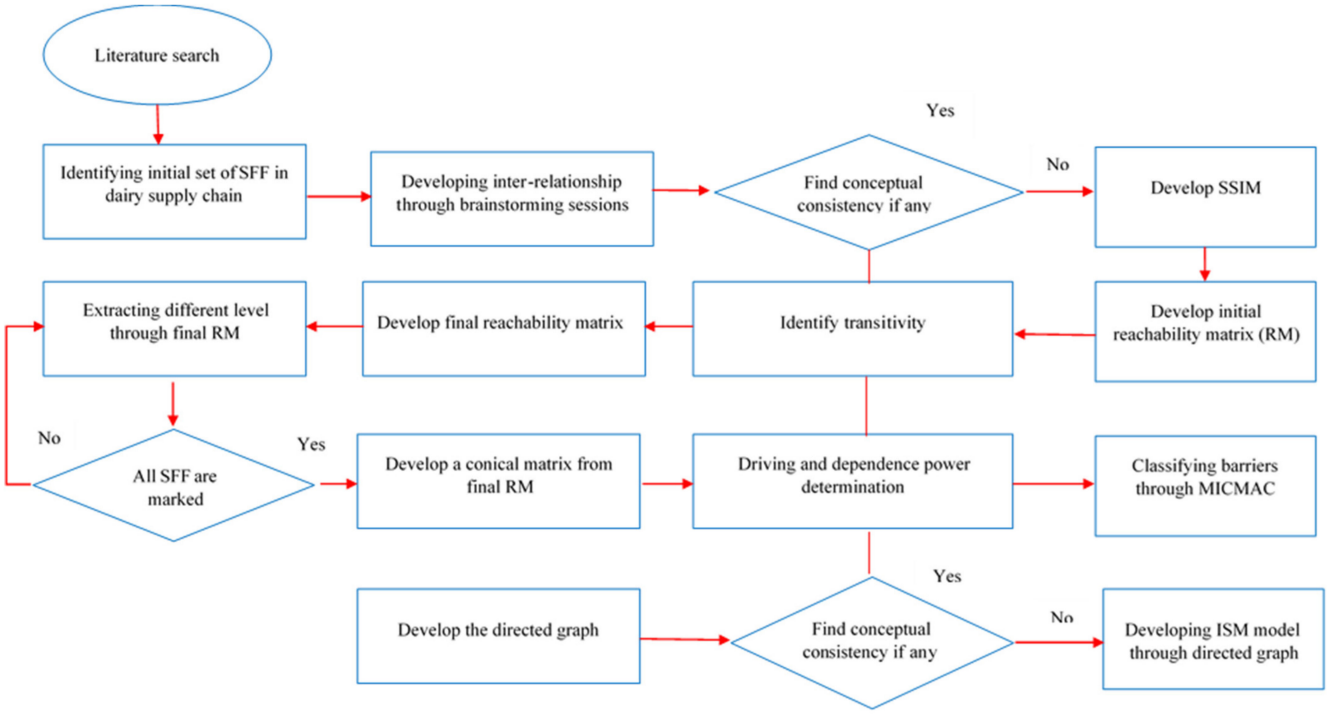

Figure 2. Methodology to develop an ISM model for SSF in the dairy supply chain.

Four letters have been used to denote the direction of the relationship between barriers i and j—V,A,X,O—similar to the previous studies, e.g., [63–65]. The description of each variable is shown below:

V: Factor "I" is related to factor "j";
A: Factor "j" is related to factor "I";
X: Factors "I" and "j" are related to each other;
O: Factors "I" and "j" are not related to each other.

This study was conducted using experts' opinions derived through brainstorming sessions. A group of experts, including one director, one dairy operation manager, three academicians (in the field of operations and supply chain management) and two dairy companies' managers (having direct links with dairy supply chain practices), were invited to rate the contextual relationship among the factors.

The rest of the experts were from Pakistan. The data were collected through a brainstorming session with different experts. All the experts were professionals, with sound knowledge in their fields. Initially, they were approached through sending emails and making phone calls. In total, 25 experts were approached, but due to their busy schedules, 7 experts agreed to participate in the brainstorming session. The sample size of seven experts is enough to meet the criteria of the ISM approach. Tan and Chen [66] used five experts as their sample to determine the barriers to building information modeling from the perspective of the Chinese construction industry. Malek and Desai [67] employed seven professionals to investigate the strategies of sustainable manufacturing, while Ravi and Shankar [63] discovered that a minimum of two experts is enough to meet the criteria of ISM.

Data were collected through a self-structured interaction matrix (SSIM)-based questionnaire, and this helped us to prioritize the identified SFFs in the Pakistani dairy industry SSIM of the SSFs is given in Table 5.

Table 5. SSIM of SFFs.

Critical Factors	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25
A1		O	O	O	A	O	A	O	O	O	O	A	X	V	O	A	A	O	O	O	O	O	O	A	A
A2			X	A	O	V	A	O	O	O	O	O	O	O	O	A	A	O	A	O	O	O	O	O	A
A3				A	O	O	A	O	O	O	O	A	V	O	O	X	O	O	O	O	O	O	O	O	O
A4					O	O	O	O	O	O	O	O	V	O	O	A	A	O	O	O	O	O	O	O	A
A5						V	A	V	O	O	O	O	O	O	O	A	A	O	O	O	O	O	O	A	A
A6							O	A	X	O	O	O	O	A	O	A	A	A	O	O	O	X	O	O	O
A7								V	O	O	O	O	O	O	O	O	A	O	O	O	O	O	O	O	A
A8									O	O	O	O	O	O	O	A	A	O	A	O	O	O	O	A	A
A9										A	A	V	A	O	V	A	A	A	A	A	V	A	A	A	A
A10											V	O	O	O	O	O	O	X	O	V	O	V	X	O	O
A11												O	V	O	O	A	A	O	O	O	O	O	V	A	A
A12													O	O	V	A	A	O	O	A	A	O	O	A	A
A13														V	O	A	A	O	O	O	O	O	O	A	A
A14															O	A	A	O	O	O	O	O	O	A	A
A15																A	A	O	O	A	X	O	O	O	A
A16																	X	O	V	V	O	V	O	A	A
A17																		V	V	V	V	V	O	X	A
A18																			O	V	O	V	V	V	V
A19																				O	O	O	O	A	A
A20																					V	X	O	A	A
A21																						O	O	A	A
A22																							O	O	A
A23																								A	A
A24																									A
A25																									

The details of all the experts are shown in Table 6.

Table 6. Experts' demographics.

Expert	Occupation	Gender	Age	Organization	Qualification	Work Experience	Firm Size
E1	Director	Male	60	Olpers dairy farm	PhD	15 years	300
E2	Diary operation manager	Male	63	Punjab dairy industry	Master	12	900
E3	professor	Male	48	Research institute	PhD	18	3500
E4	Associate professor	Male	37	Research institute	PhD	10	3500
E5	Associate professor	Female	38	Research institute	PhD	5	2200
E6	manager	Male	53	Dairy farm	Bachelor	17	35
E7	Dairy supply manager	Male	57	Dairy farm	Bachelor	13	27

3.2.2. Initial Reachability Matrix (IRM)

Once the SSIM has been developed, it is transformed into binary digits 0 and 1, known as the initial reachability matrix. The directions for transforming the SSIM into the IRM are given below:

- Suppose factors i and j are listed in SSIM as "V", then in IRM, (i,j) will be listed as 1 and (j,i) as 0;
- Suppose factors i and j are listed in SSIM as "A", then in IRM, (i,j) will be listed as 0 and (j,i) as 1;

- Suppose factors i and j are listed in SSIM as "X", then in IRM, (i,j) will be listed as 1 and (j,i) as 1;
- Suppose factors i and j are listed in SSIM as "O", then in IRM, (i,j) will be listed as 0 and (j,i) as 0.

The transformation of SSIM into IRM is shown in Table 7.

Table 7. Initial reachability matrix.

VAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
2	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
4	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
5	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
7	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0
10	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	1	0	1	1	0	0
11	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
12	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
13	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
16	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	1	1	0	1	0	0	0
17	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0
18	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1
19	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	1	1	1	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0
22	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
23	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
24	1	0	0	0	1	0	0	1	1	0	1	1	1	1	0	1	1	0	1	1	1	0	1	1	0
25	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1

3.2.3. Final Reachability Matrix (FRM)

After the construction of the initial reachability matrix, the final reachability matrix is obtained by adding 1* entries into the initial reachability matrix, to incorporate transitivity. Transitivity is a basic assumption at this stage, which states that if variable "X" is associated with variable "Y" and "Y" is associated with "Z", then "X" must be associated with "Z".

The conversion of IRM into FRM is shown in Table 8.

3.2.4. Level Partition

After developing the final reachability matrix, the reachability sets and antecedent sets of each factor were obtained from the final reachability matrix. The reachability set includes the factor itself and other factors that it may help to determine, while the antecedent set includes the factor itself and other factors that may help it to be achieved. The similar values of the reachability set and the antecedent set were added into another set called the intersection set. Thereafter, level partition was performed. After the allocation of each factor, their levels were also eliminated accordingly. This process was continued until all factors were allocated levels. Through this process, the SFFs were divided into twelve levels. The twelve levels of iteration are shown in Table 9.

Table 8. Final reachability matrix.

VAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Driving Power
1	1	0	0	0	0	1 *	0	0	1 *	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	**5**
2	0	1	1	0	0	1	0	0	1 *	0	0	0	1 *	0	0	1 *	0	0	0	0	0	1 *	0	0	0	**7**
3	1 *	1	1	0	0	1 *	0	0	1 *	0	0	0	1	1 *	0	1	0	0	0	0	0	1 *	0	0	0	**9**
4	1 *	1	1	1	0	1 *	0	0	1 *	0	0	0	1	1 *	0	1 *	0	0	0	0	0	1 *	0	0	0	**10**
5	1	0	0	0	1	1	0	1	1 *	0	0	0	1 *	1 *	0	0	0	0	0	0	0	1 *	0	0	0	**8**
6	0	0	0	0	0	1	0	0	1	0	0	1 *	0	0	1 *	0	0	0	0	1 *	1 *	1	0	0	0	**7**
7	1	1	1	1 *	1	1 *	1	1	1 *	0	1 *	1 *	1 *	1 *	1 *	1 *	1 *	0	1 *	1 *	1 *	1 *	0	0	0	**20**
8	0	0	0	0	0	1	0	1	1 *	0	0	1 *	0	0	1 *	0	0	0	0	1 *	1 *	1 *	0	0	0	**8**
9	1 *	0	1 *	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1 *	1	1 *	0	0	0	**9**
10	1 *	0	1 *	0	0	1 *	0	0	1	1	1	1 *	1 *	0	1 *	0	0	1	0	1	1 *	1	1	1	1 *	**16**
11	1 *	0	1 *	0	0	1 *	0	0	1	0	1	1 *	1	1 *	1 *	0	0	0	0	1 *	1 *	1 *	1	1	0	**13**
12	1	1 *	1	0	0	1 *	0	0	1 *	0	0	1	1 *	1 *	1	1 *	0	0	0	0	0	1 *	0	0	0	**11**
13	1	0	1 *	0	0	1 *	0	0	1	0	0	1 *	1	1	1 *	0	0	0	0	1 *	1 *	1 *	0	0	0	**11**
14	0	0	0	0	0	1	0	0	1 *	0	0	1 *	0	1	1 *	0	0	0	0	1 *	1 *	1 *	0	0	0	**8**
15	0	0	0	0	0	0	0	0	0	0	0	1 *	0	0	1	0	0	0	0	0	1	0	0	0	0	**3**
16	1	1	1	1	1	1	1 *	1	1	0	1	1	1	1	1	1	1	1 *	1	1	1 *	1	1 *	1 *	0	**23**
17	1	1	1 *	1	1	1	1	1	1	1 *	1	1	1	1	1	1	1	1	1	1	1	1	1 *	1 *	1 *	**25**
18	1 *	1 *	1 *	1 *	1 *	1	1 *	1 *	1	1	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1	1 *	1	1 *	1	1	1	1	**25**
19	1 *	1	1 *	0	0	1 *	0	1	1	0	0	1 *	1 *	0	1 *	1 *	0	0	1	1 *	1 *	1 *	0	0	0	**14**
20	1 *	1 *	1 *	0	0	1 *	0	0	1	0	0	1	1 *	1 *	1	1 *	0	0	0	1	1	1	0	0	0	**13**
21	1 *	1 *	1 *	0	0	1 *	0	0	1 *	0	0	1	1 *	1 *	1	1 *	0	0	0	0	1	1 *	0	0	0	**12**
22	1 *	1 *	1 *	0	0	1	0	0	1	0	0	1 *	1 *	1 *	1 *	1 *	0	0	0	1	1 *	1	0	0	0	**13**
23	1 *	0	1 *	0	0	1 *	0	0	1	1	1 *	1 *	1 *	0	1 *	0	0	1 *	0	1 *	1 *	1 *	1	1	1 *	**16**
24	1	1 *	1 *	0	1	1 *	1 *	1	1	1 *	1	1	1	1	1 *	1	1	1 *	1	1	1	1 *	1	1	1 *	**24**
25	1	1	1 *	1	1	1 *	1	1	1	1 *	1	1	1	1	1	1	1	1 *	1	1	1	1	1	1	1	**25**
Dependence Power	**20**	**14**	**19**	**6**	**7**	**24**	**6**	**9**	**24**	**6**	**9**	**20**	**20**	**17**	**20**	**14**	**6**	**7**	**7**	**17**	**19**	**23**	**8**	**7**	**6**	**335**

* transitivity links.

Table 9. Deriving levels from FRM.

Sr.#	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,6,9,13,14	1,3,4,5,7,9,10,11,12,13,16,17,18,19,20,21,22,23,24,25	1,9,13	**IV**
2	2,3,6,9,13,16,22	2,3,4,7,12,16,17,18,19,20,21,22,24,25	2,3,16,22	**V**
3	1,2,3,6,9,13,14,16,22	2,3,4,7,9,10,11,12,13,16,17,18,19,20,21,22,23,24,25	2,3,9,13,16,22	**V**
4	1,2,3,4,6,9,13,14,16,22	4,7,16,17,18,25	4,16	**VI**
5	1,5,6,8,9,13,14,22	5,7,16,17,18,24,25	5	**X**
6	6,9,12,15,20,21,22	1,2,3,4,5,6,7,8,9,10,11,12,13,14,16,17,18,19,20,21,22,23,24,25	6,9,12,20,21,22	**II**
7	1,2,3,4,5,6,7,8,9,11,12,13,14,15,16,17,19,20,21,22	7,16,17,18,24,25	7,16,17	**XI**
8	6,8,9,12,15,20,21,22	5,7,8,16,17,18,19,24,25	8	**IX**
9	1,3,6,9,12,15,20,21,22	1,2,3,4,5,6,7,8,9,10,11,12,13,14,16,17,18,19,20,21,22,23, 24,25	1,3,6,9,12,20,21,22	**III**
10	1,3,6,9,10,11,12,13,15,18,20,21,22,23,24,25	10,17,18,23,24,25	10,18,23,24,25	**X**
11	1,3,6,9,11,12,13,14,15,20,21,22,23	7,10,11,16,17,18,23,24,25	11,23	**IX**
12	1,2,3,6,9,12,13,14,15,16,22	6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25	6,9,12,13,14,15,16,22	**VI**
13	1,3,6,9,12,13,14,15,20,21,22	1,2,3,4,5,7,10,11,12,13,16,17,18,19,20,21,22,23,24,25	1,3,12,13,20,21,22	**IV**
14	6,9,12,14,15,20,21,22	1,3,4,5,7,11,12,13,14,16,17, 18,20,21,22,24,25	12,14,20,21,22	**III**
15	12,15,21	6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25	12,15,21	**I**
16	1,2,3,4,5,6,7,8,9,11,12,13, 14,15,16,17,18,19,20,21,22,23,24	2,3,4,7,12,16,17,18,19,20,21,22,24,25	2,3,4,7,12,16,17,18,19,20,21, 22,24	**XI**
17	1,2,3,4,5,6,7,8,9,10,11,12, 13,14,15,16,17,18,19,20,21,22,23, 24,25	7,16,17,18,24,25	7,16,17,18,24,25	**XI**
18	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23, 24,25	10,16,17,18,23,24,25	10,16,17,18,23,24,25	**XII**
19	1,2,3,6,8,9,12,13,15,16,19,20,21,22	7,16,17,18,19,24,25	16,19	**X**
20	1,2,3,6,9,12,13,14,15,16,20,21,22	6,7,8,9,10,11,13,14,16,17,18,19,20,22,23,24,25	6,9,13,14,16,20,22	**VIII**
21	1,2,3,6,9,12,13,14,15,16,21,22	6,7,8,9,10,11,13,14,15,16,17,18,19,20,21,22,23,24,25	6,9,13,14,15,16,21,22	**VII**
22	1,2,3,6,9,12,13,14,15,16,20,21,22	2,3,4,5,6,7,8,9,10,11,12,13,14,16,17,18,19,20,21,22,23,24	2,3,6,9,12,13,14,16,20,21,22	
23	1,3,6,9,10,11,12,13,15,18,20,21,22,23,24,25	10,11,16,17,18,23,24,25	10,11,18,23,24,25	**IX**
24	1,2,3,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25	10,16,17,18,23,24,25	10,16,17,18,23,24,25	**XII**
25	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25	10,17,18,23,24,25	10,17,18,23,24,25	**XII**

3.2.5. ISM-Based Hierarchal Model

After level partitioning, the hierarchal structure of the SFFs in the supply chain of the dairy industry in Pakistan were developed, resulting in a diagraph. Thereafter, the transitive links were removed based on the relationships given in the final reachability matrix. The final ISM-based model is shown in Figure 3.

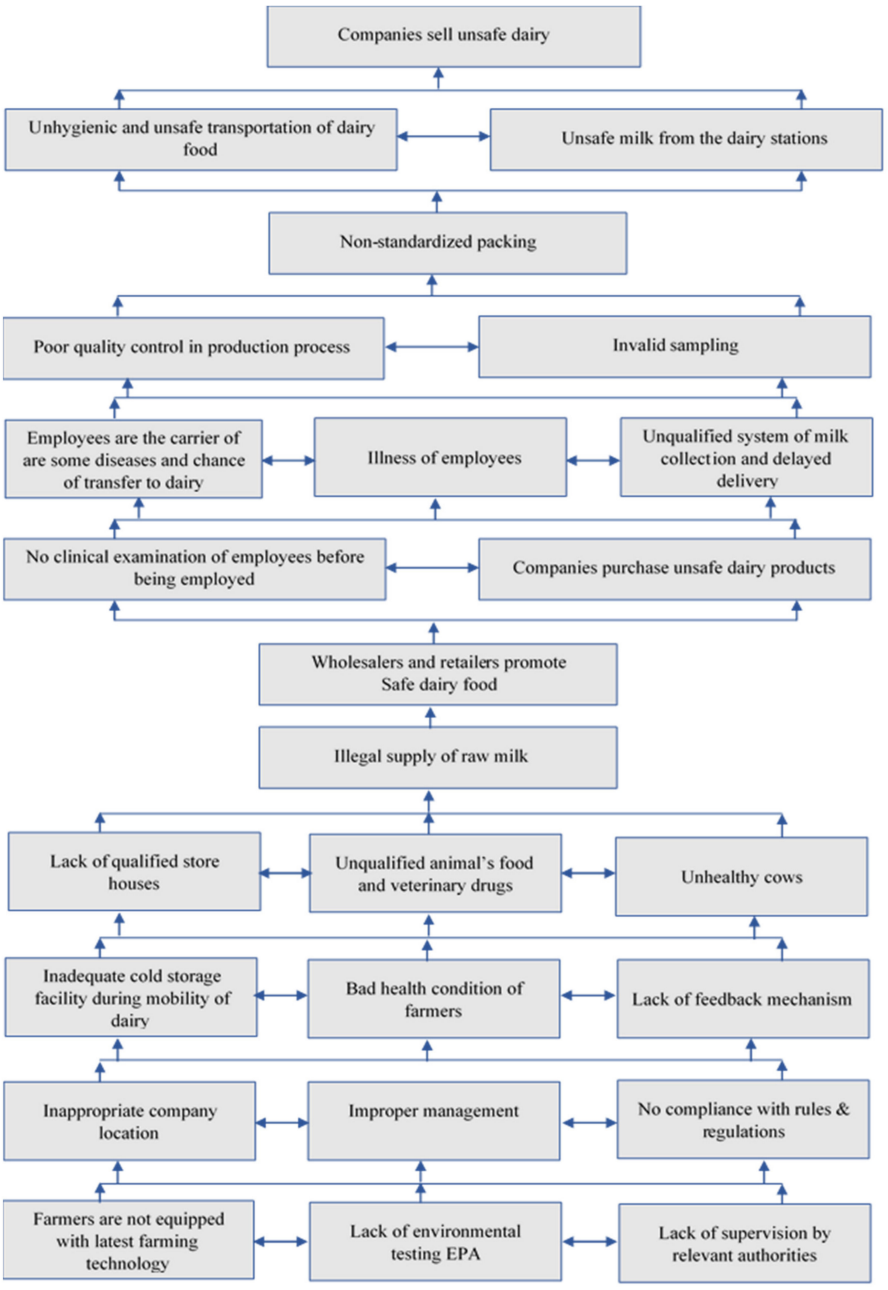

Figure 3. ISM-based model of safety failure factors of the dairy supply chain.

3.3. MICMAC Analysis

MICMAC was introduced by [68]. It is based on the multiplication properties of matrices. In this study, we used MICMAC with ISM in the problem evaluation. In addition, the combined use of these two approaches can assist in understanding the level of importance of each of the considered variables through well-described diagrams (ISM-based hierarchical diagram and classification-based MICMAC analysis). MICMAC analysis was carried out for the validation of the hierarchically structural model of the

described implementation factors. In the ISM technique, we considered four probable relations to examine the interactions among the decision variables; however, we could not classify the strength of the contextual relations among these variables. MICAC analysis, on the other hand, can effectively classify the contextual relations among the decision variables and describe the directions and levels of considered variables. Finally, the purpose of this approach is to examine the power of the driving and dependence forces of the described barriers. This is used to formulate dairy supply chains by dividing the barriers into four clusters. These four clusters are as follows.

3.3.1. Autonomous Factors

This includes factors whose driving power and dependence power are both weak. These barriers are relatively disconnected from each other, but have some links that might be strong. The factors in the autonomous clusters are A4, A5, A8 and A11.

3.3.2. Dependent Factors

The cluster of dependent factors has insufficient driving power to drive other barriers, but their dependence power is strong. Dependent factors include A1, A2, A3, A6, A9, A12, A13, A14, A15, A20, A21, and A22.

3.3.3. Linkage Factors

The driving power and dependence power of the linkage factors are both strong, and therefore, these factors are considered to be unstable. In this sense, any impact on these factors also influences other factors. The A16 factor is a linkage factor.

3.3.4. Independent Factors

Independent factors represent the factors with strong driving power but weak dependence power. These include A7, A10, A17, A18, A19, A23, A24 and A25.

The results of the MICMAC analysis are shown in Figure 4.

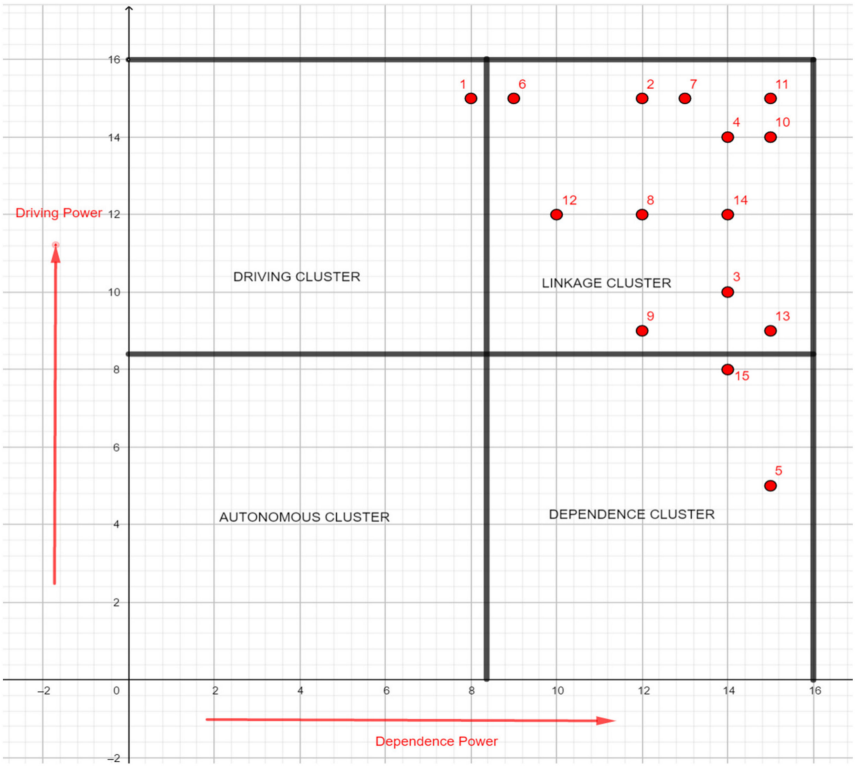

Figure 4. MICMAC analysis of safety failure factors of the dairy supply chain.

4. Results and Discussion

The SFFs (A25) Lack of supervision by relevant authorities, (A24) Lack of environmental testing by the environmental protection agency (EPA) and (A18) Farmers are not equipped with the latest farming technology emerged as the most critical according to the ISM hierarchical framework. These factors are included in level twelve. There is a lack of sufficient supervision by relevant authorities (A25) in the dairy sector of Pakistan. The restricted flow of information across the hierarchy of organizations affects the milk supply chain system. The collaboration of research and support by relevant authorities is required in this context. Organizations require coordination with between personnel and stakeholders to show them how the company's goals are aspired to in their day-to-day functions. (A24) Lack of environmental testing by environmental protection agency (EPA) is another critical safety factor in the dairy industry, because environmental rules and regulations are not implemented properly in this sector, despite how significant they are. There is lack of environmental literacy. The implementation of environmental testing is important in maintaining effectiveness in supply chain systems [69]. The Pakistani government should take action to regulate the EPA's polices appropriately in the dairy industry. Another critical factor is (A18) Farmers are not equipped with the latest farming technology. The adoption of advanced technology and processes is very slow in Pakistan's dairy industry. Farmers are unfamiliar with the latest technology and keep using old methods. Moreover, farmers are hesitant to adopt the latest technology and processes because of their superstitious beliefs and traditional organizational structure. Technologies including milk meters, weight scales, mastitis detection and activity meters can be used to assist on-farm decision-making, and also improve the safety performance of the dairy supply chain. Dairy labor efficiency has been improved recently using automatic cluster removers (ACRs) on farms [70]. The government should educate farmers about the potential benefits of various technologies, along with process automation, and ensure appropriate investment decisions are made.

Level eleven includes three factors, namely, (A17) No compliance with the rules and regulations, (A16) Improper management and (A7) Inappropriate company location, which are also significant SFFs in the dairy supply chain of Pakistan. There is severe negligence of the rules and regulations in the dairy sector of Pakistan, which is one of the big issues. The government should develop effective courses and regulations, and ensure the dairy sector follows them properly in order to stabilize the supply chain system. Improper management (A16) is another issue that makes milk production low. There is resistance to introducing change into the existing dairy supply chain system, including investments, information and production systems, etc. The top management should strengthen its leadership skills by ensuring the right person is employed in the right place. To enhance the productivity of the organization, the top management should mitigate managerial-level conflicts [71]. Inappropriate company location (A7) is one of the big factors influencing safety performance and milk production. Most dairy companies are located out of cities in Pakistan, and this huge distance between company and end customer creates a big gap between demand and supply. Poorly constructed roads, weather challenges and traffic jams are the most common factors affecting the milk supply chain system. The relocation of dairies from regions rich in water resources to regions with limited resources is likely to be shortsighted [72].

(A19) Lack of feedback mechanism, (A10) Bad health condition of farmers and (A5) Inadequate cold storage facility during mobility of dairy food are all included at level ten. These are also important safety factors in the dairy industry of Pakistan. The lack of feedback mechanisms (A19) is also a problem in the dairy industry. There is no trend of giving feedback about the quality of milk, dairy products, production process, supply chain systems, etc., in a formal way. Dairy companies should establish a consumer-oriented feedback mechanism and give immediate responses upon receiving consumer complaints, and they should prevent further deterioration by keeping confidential records. The next factor is (A10) Bad health condition of farmers. Farmers suffer from an increased occurrence of many acute and chronic health conditions, including skin cancer, hearing loss, amputations

and respiratory diseases, etc. Other health issues have rarely been studied in the agriculture sector, such as stress and adverse reproductive outcomes [73,74]. The majority of livestock-handling claims were made by males (88%) and by employees on farms employing eleven or more workers (87%) [75]. The government should develop policies of better medical treatment for farmers so they can work effectively. (A5) Inadequate cold storage facilities during mobility of dairy food is also a big issue causing the wastage of milk. Hence, the lack of modern technology, especially decent refrigerator facilities, is the main cause of wastage of milk. As the weather in Pakistan is very hot during summer, and electricity is in short supply, huge amounts of dairy products are wasted during transportation, which leads to high production costs.

Factors including (A23) Unhealthy cows, (A11) Unqualified animals' food and veterinary drugs and (A8) Lack of qualified storehouse fall into level nine. Underdeveloped farms and unbalanced diets are the main reasons for unhealthy cows (A23), which tends to result in the low production of milk. The government should develop easy policies for farmers to access loans so that they can develop their farms. At the same time, farmers should pay attention to animal health by providing proper food and drugs, as well as ensuring some precautions, including noise reduction to reduce animal agitation, nonslip flooring, proper lighting for ease of animal movement, and distraction removal in order to prevent balking. (A11) Unqualified animals' food and veterinary drugs is also a critical issue. Due to the lack of knowledge and training, farmers are unfamiliar with qualified food and veterinary drugs. They are used to traditional treatments. However, the failure to keep to the withdrawal period, including when using potential overdose and long-acting drugs, might be the reason for the presence of unacceptable residues [34]. Government and dairy companies should develop programs to educate farmers regarding vaccination, mastitis, nutrition, and metabolic and reproductive problems. Furthermore, they should hire qualified veterinary doctors on dairy farms. Another factor is (A8) lack of a qualified storehouse, which is one of the big reasons for the wastage of food. The safety of food is a serious problem, even in developed countries, where 15.7 million people are undernourished. There is a need to stop further wastage of food because the world population is growing rapidly [27]. The wastage of food has economic implications in the food supply chain (i.e., farmer, producer and consumer). Food losses have a negative impact on the incomes of both farmers and consumers [76,77]. Further, food loss is also a reason to reduce the financial resources that are applied here and that can be used for investment in other areas. The relevant authorities must be aware of this problem and take adequate measures towards the reduction of dairy food wastage.

Level eight contains a single barrier of (A20) Illegal supply of raw milk. This is a critical barrier in the Pakistan dairy sector. About 97% of dairy farming is not linked with formal dairy channels, which makes economic productivity low (PDDC, 2006). The extra milk leftover after meeting household needs is mostly sold to informal market chains, shopkeepers, directly to consumers, to middlemen and to brokers [26]. The government should take serious action in terms of legalized milk supply in order to avoid monitory losses in the dairy sector.

Level seven includes (A21) Wholesalers and retailers promote unsafe dairy food. The milk products and byproducts in the country include pasteurized milk, powdered milk, ultra-high-temperature (UHT) milk, butter, cream, yogurt, ghee and cheese. Wholesalers and retailers distribute unsafe dairy food by changing the shelf-life or selling at a low price just for the sake of their own short-term interest, which leads to food security issues for consumers [78]. Companies purchase unsafe dairy foods (A12) and carry out no clinical examinations of their employees before being employed (A4). These factors comprise level six. (A12) companies purchase unsafe dairy food because they only focus on their own interests, and they pay much less to dairy farmers. On the other hand, to make a good profit, farmers mix water in milk and use low-quality milk powder in other dairy products to increase production. As a result, consumers pay high, but get poor-quality dairy products, which may lead to diseases. The government and other regulatory departments

should carry out inspections of these companies, and devise strict rules related to dairy safety issues. (A4) No clinical examination of employees before being employed is another noticeable issue in the dairy industry of Pakistan. Most dairy farms do not carry out physical examinations when hiring their workers. Some employees with bad health conditions bring different diseases, which may be transferred to other employees and animals as well. Dairy management should require the physical examination of employees before hiring, so the risk of carrying diseases into dairy sector can be reduced.

Level five of the ISM hierarchal model includes (A22) unqualified system of milk collection and delayed delivery, (A3) Illness of employees and (A2) Employees are the carrier of some disease and chance of transfer to dairy. Unqualified systems of milk collection and delayed delivery (A22) is an important SFF. Because of the underdeveloped infrastructure of roads and electricity, and the lack of new technologies in the Pakistani dairy sector, the system of milk collection and milk delivery is poor. Farmers are mostly illiterate, so they do not have a proper record of milk collection, which is one of the big causes of the wastage of milk. Sometime, in milk collection, there is double counting, and sometimes milk collection is not recorded even once, and that is why it is difficult to share the exact quantity of milk production with regulatory bodies. In addition, as most dairy farms in Pakistan live in rural areas, the great distances of farms from urban markets combined with poor transportation systems is a main reason for delayed delivery. This affects the inputs and outputs and the ease of production [79]. The government should make policies regarding milk supply chain systems, and create development programs to increase the ease of milk delivery. (A3) Illness of employees affects the production process. Farm workers are exposed to extreme health risks on a daily basis, related to handling large animals in dairy farms. Employees need to work hard when feeding calves, managing manure and nutrition and using machinery. However, if they are suffering from a bad health condition, they will not be able to perform their duties properly. Occupational safety and health administration (OHSMS) refers to a series of policies, regulations and plans that lay out how an organization can manage occupational health and safety (OHS) issues. The International Labor Organization has also added the guidelines of the OHSM on safety and health into their code of practice (International Labor Organization, 2010). The government of Pakistan should enact health and safety programs for the proper inspection of dairies. (A2) employees are the carrier of some disease and chance of transfer to dairy. This relates to various diseases, including Q fever, rabies, brucellosis, giardiasis, Escherichia coli (E. coli), cryptosporidium, etc., that are transmitted from humans to animals or vice versa. Sometimes, when employees get sick and work with animals, there is a high risk of exposure to various diseases (i.e., infections caused by virus and bacteria). This is a dangerous situation for both dairy employees and animals, causing infections that can easily be transferred from employees to dairy animals. Employee sickness can be prevented by not using unpasteurized dairy products, wearing gloves when handling reproductive tissues, and washing hands after handling animals. The management of the dairy sector should report these cases and undertake safety measures.

(A13) Invalid sampling and (A1) Poor quality control in production process are factors that fall into level four. These are less important SFFs as compared to the above-discussed factors, but they still require the attention of the organization and the government in order to improve the dairy system. (A13) Invalid sampling—the accurate sampling of dairy products is significant, as they have a short lifetime, which causes unstable demand, influenced by dynamic and expressive environmental responses, none of which is addressed in the dairy sector [80,81]. The aim of sampling programs includes quality assurance, regulation, and accurate cost information. The key to deriving accurate results from quality and composition tests include representative sampling and subsequent proper handling. Training and supervision must be supplied to the persons involved in collecting and handling the sampling. The management of the dairy sector should be attentive to invalid sampling, and make strict policies for the valid sampling of milk to improve the dairy industry. (A1) Poor quality control in the production process; there is no provision for

quality issues in the milk production process in the dairy sector of Pakistan. The traceability of quality milk inhibits non-value-added (NVA) programs due to the sampling and testing of milk, this issue is a significant factor in the dairy sector [17]. In addition, national dairy product safety test standards and detection systems are very poor in the Pakistani dairy industry. The ministry of health and other government regulatory authorities should take measures to improve the quality standards of the dairy production process.

The issue of non-standardized packaging (A14) falls into level three. Non-standardized packaging leads to a reduction in the shelf life of dairy products, which is a common issue in the dairy industry of Pakistan. As milk and other dairy products, such as powdered milk, butter, ice cream, and cheese, are highly perishable, the quality, safety, cost, and marketing of these products rely closely on their packaging material. Recently, interest in smart packaging has developed in the dairy industry, which has affected sustainability and the atmosphere as well. The government of Pakistan should provide the dairy industry with the latest developments in packaging, including modified atmosphere packaging (MAP) and active packaging, to control some of the associated fungal problems and extend the shelf life of dairy products. Level two consists of two factors, including (A9) Unsafe milk from the dairy stations and (A6) Unhygienic and unsafe transportation of dairy food. As most dairy farms are situated in rural areas, and because of the poor transportation system, farmers and local milk sellers use bicycles, motorbikes, and open vehicles for the delivery or collection of dairy products, which is unhygienic and unsafe. Level one includes (A15) companies sell unsafe dairy products; sometimes, even big companies perform unethical acts in selling unsafe dairy products at low prices, or even at market rates, to maintain their profits (earning per share). These are the least important factors in the dairy sector of Pakistan. If the government and dairy sector paid a little attention to these issues, they could improve the supply chain system of the dairy industry.

5. Conclusions

This study investigates the SFFs in the supply chain of the dairy industry in Pakistan. Twenty-five factors have been identified in this study. The ISM technique was used to identify the contextual relationships among different factors. The MICMAC approach assists the researchers in understanding the significance of barriers in a systematic way. SFFs that have a greater influencing capacity are listed in independent and linked quadrants of the MICMAC analysis.

The results of this study show that SFFs (A15) Companies sell unsafe dairy products, (A25) Lack of supervision by relevant authorities, (A24) Lack of environmental testing by the environmental protection agency (EPA) and (A18) Farmers are not equipped with the latest farming technology are the main SFFs in the dairy supply chain of Pakistan. These factors need more attention from the government and relevant authorities. The manual approach to milk handling is one of the most critical reasons for the wastage of a high quantity of milk. Dairy industries must improve their management systems, especially as regards supervision, information, technical, operational, wastage and transportation. Moreover, a remuneration system could also be fruitful in improving the overall productivity of the dairy industry.

Earlier studies have examined the productivity barriers and critical factors in dairy supply chains, but they have not proposed any rankings among those SFFs. Thus, the current study has generalized the application of ISM for assessing the interaction among SFFs in the supply chain of the dairy industry. Finally, this study is significant for both the dairy industry and academics, because no study has yet related the factors/barriers and their rankings in a real-time industrial scenario for Pakistan. The proposed study can help decision-makers in the dairy industry of Pakistan eradicate the SFFs in the supply chain, plan their supply chain activities more effectively, and gain an advantage over competitors.

5.1. Theoretical and Practical Implications

In conducting this study, many other studies were analyzed. Many address the critical factors in the dairy supply chain in different areas, but none so far have identified SFFs in the Pakistani context. As such, the purpose of this study is to address the critical factors in the supply chain of the dairy industry in Pakistan by applying ISM and MICMAC techniques.

The theoretical implication of the ISM approach is that it shows the interrelationships among variables in a hierarchical model with multiple, complex levels. Theoretically, this study is novel in the context of the dairy supply chain. The lack of literature in this area makes this research essential to academicians and researchers. Many studies relate to the critical barriers in the supply chain of the dairy industry, but none have recognized the SFFs and their causes in detail in the Pakistani context. Additionally, previous studies have not highlighted such issues, meaning these SSFs are novel in the literature on developing countries.

The practical steps that should be taken to overcome the safety failures in the dairy supply chain include farmers not being equipped with the latest technology. If the top management of the dairy industry would consider such factors when designing long-term strategic policies, and equip their workers with advanced technology, then the production of milk could be increased. To manage the environmental concerns, such as the testing of dairy foods according to environmental concerns, dairy professionals need to focus on local, national and global policies. Technical issues should be mitigated through the adoption of innovative technology in the dairy sector; therefore, the top leadership should recruit technically skilled employees who can help to redevelop the production process of dairy products. Additionally, the lack of supervision by relevant authorities is a major issue that could be removed through the development of proper policies. Professionals and other concerned authorities should formulate policies and enforce them to the benefit of the dairy industry.

5.2. Limitations of Study and Directions for Future Research

There are some limitations to this study; for example, this study has been conducted from the perspective of Pakistan, and critical factors have been identified through the opinions of experts. Thus, a new framework can be established based on the data collected from stakeholders, which can provide a different view. In addition, the ISM technique has been used in this study, which assists in formulating the initial model, and shows that there is no authenticity in the statistical relationships among different barriers. Further, any model that assigns weightage to the identified barriers with statistical tools, such as structural equation modeling (SEM), can be used in future studies. Moreover, the barriers were selected with reference to experts' opinions. Finally, a different view can be derived by collecting data from stakeholders.

In Pakistan, there is a dire need to improve production per animal per head. In this regard, different application programs can encourage through the efficient use of local feed resources, the application of improved feed management, and the development of alternatives. Research institutes should communicate with private sectors to deliver mechanisms and technologies at the grass roots level. The methodology of this study may be generalized for other perishable food processing industries, such as meat, poultry, fishery, etc. However, the government and other concerned authorities should cooperate with each other to mitigate barriers. Future studies can be conducted for different interfaces of the dairy supply chain.

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References

1. Haghighat, F. The impact of information technology on coordination mechanisms of supply chain. *World Appl. Sci. J.* **2008**, *3*, 74–81.
2. Sartorius, K.; Kirsten, J. A framework to facilitate institutional arrangements for smallholder supply in developing countries: An agribusiness perspective. *Food Policy* **2007**, *32*, 640–655. [CrossRef]
3. Handford, C.E.; Campbell, K.; Elliott, C.T. Impacts of milk fraud on food safety and nutrition with special emphasis on developing countries. *Compr. Rev. Food Sci. Food Saf.* **2016**, *15*, 130–142. [CrossRef]
4. Mor, N.; Dardeck, K.L. Mitigation of posttraumatic stress symptoms from chronic terror attacks on southern Israel. *J. Soc. Behav. Health Sci.* **2017**, *11*, 2.
5. Mor, R.; Singh, S.; Bhardwaj, A.; Singh, L. Technological implications of supply chain practices in agri-food sector: A review. *Int. J. Supply Oper. Manag.* **2015**, *2*, 720–747.
6. Mor, R.S.; Bhardwaj, A.; Singh, S. A structured literature review of the Supply Chain practices in Food Processing Industry. In Proceedings of the 2018 International Conference on Industrial Engineering and Operations Management, Bandung, Indonesia, 6–8 March 2018.
7. Mathiyazhagan, K.; Agarwal, V.; Appolloni, A.; Saikouk, T.; Gnanavelbabu, A. Integrating lean and agile practices for achieving global sustainability goals in Indian manufacturing industries. *Technol. Forecast. Soc. Chang.* **2021**, *171*, 120982. [CrossRef]
8. Pan, Y.; Wu, D.; Luo, C.; Dolgui, A. User activity measurement in rating-based online-to-offline (O2O) service recommendation. *Inf. Sci.* **2019**, *479*, 180–196. [CrossRef]
9. Mor, R.; Singh, S.; Bhardwaj, A. Learning on lean production: A review of opinion and research within environmental constraints. *Oper. Supply Chain Manag. Int. J.* **2015**, *9*, 61–72. [CrossRef]
10. Bhardwaj, A.; Mor, R.S.; Singh, S.; Dev, M. An investigation into the dynamics of supply chain practices in Dairy industry: A pilot study. In Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management, Detroit, MI, USA, 23–25 September 2016.
11. Yorifuji, T.; Kashima, S.; Higa Diez, M.; Kado, Y.; Sanada, S. Prenatal exposure to traffic-related air pollution and child behavioral development milestone delays in Japan. *Epidemiology* **2016**, *27*, 57–65. [CrossRef]
12. Kumar, N.; Kumar, H.; Mann, B.; Seth, R. Colorimetric determination of melamine in milk using unmodified silver nanoparticles. *Spectrochim. Acta Part A Mol. Biomol. Spectrosc.* **2016**, *156*, 89–97. [CrossRef]
13. Park, M.S.; Kim, H.N.; Bahk, G.J. The analysis of food safety incidents in South Korea, 1998–2016. *Food Control* **2017**, *81*, 196–199. [CrossRef]
14. Mor, R.S.; Bhardwaj, A.; Singh, S. Benchmarking the interactions among performance indicators in dairy supply chain. *Benchmarking Int. J.* **2018**, *25*, 3858–3881. [CrossRef]
15. Nicholas, P.K.; Mandolesi, S.; Naspetti, S.; Zanoli, R. Innovations in low input and organic dairy supply chains—What is acceptable in Europe? *J. Dairy Sci.* **2014**, *97*, 1157–1167. [CrossRef]
16. Nicholson, C.F.; Stephenson, M.W. Milk price cycles in the US dairy supply chain and their management implications. *Agribusiness* **2015**, *31*, 507–520. [CrossRef]
17. Issar, G.S.; Cowan, R.T.; Woods, E.J.; Wegener, M. Dynamics of Australian dairy-food supply chain: Strategic options for participants in a deregulated environment. In Proceedings of the Sixth International Conference on Chain and Network Management in Agribusiness and the Food Industry, Ede, The Netherlands, 27–28 May 2004; pp. 458–464.
18. Mangla, S.K.; Govindan, K.; Luthra, S. Critical success factors for reverse logistics in Indian industries: A structural model. *J. Clean. Prod.* **2016**, *129*, 608–621. [CrossRef]
19. Perron, G.M. *Barriers to Environmental Performance Improvements in Canadian SMEs*; Dalhousie University: Halifax, NS, Canada, 2005.
20. Bharti, M.A. Examining market challenges pertaining to cold chain in the frozen food industry in Indian retail sector. *J. Manag. Sci. Technol.* **2014**, *2*, 33–40.
21. Chandrasekaran, N.; Raghuram, G. *Agribusiness Supply Chain Management*; CRC Press: New York, NY, USA, 2014.
22. Goswami, M.; De, A.; Habibi, M.K.; Daultani, Y. Examining freight performance of third-party logistics providers within the automotive industry in India: An environmental sustainability perspective. *Int. J. Prod. Res.* **2020**, *58*, 7565–7592. [CrossRef]
23. Choudhary, A.; De, A.; Ahmed, K.; Shankar, R. An integrated fuzzy intuitionistic sustainability assessment framework for manufacturing supply chain: A study of UK based firms. *Ann. Oper. Res.* **2021**, 1–44. [CrossRef]

24. Kumar, A.; Staal, S.J.; Singh, D.K. Smallholder dairy farmers' access to modern milk marketing chains in India. *Agric. Econ. Res. Rev.* **2011**, *24*, 243–254.
25. Pant, R.; Prakash, G.; Farooquie, J.A. A framework for traceability and transparency in the dairy supply chain networks. *Procedia Soc. Behav. Sci.* **2015**, *189*, 385–394. [CrossRef]
26. Berem, R.M.; Obare, G.; Bett, H. Analysis of factors influencing choice of milk marketing channels among dairy value chain actors in Peri-urban Areas of Nakuru County, Kenya. *Kenya Eur. J. Bus. Manag.* **2015**, *7*, 174–179.
27. Buzby, J.C.; Hyman, J. Total and per capita value of food loss in the United States. *Food Policy* **2012**, *37*, 561–570. [CrossRef]
28. Lemma, Y.; Kitaw, D.; Gatew, G. Loss in perishable food supply chain: An optimization approach literature review. *Int. J. Sci. Eng. Res.* **2014**, *5*, 302–311.
29. Walker, S.L.; Smith, R.F.; Routly, J.E.; Jones, D.N.; Morris, M.J.; Dobson, H. Lameness, activity time-budgets, and estrus expression in dairy cattle. *J. Dairy Sci.* **2008**, *91*, 4552–4559. [CrossRef]
30. Hemme, T.; Otte, J. *Status and Prospects for Smallholder Milk Production: A Global Perspective*; Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2010.
31. Chalupkova, E. Application of Multiple Criteria Method of Analytic Hierarchy Process and Sensitivity Analysis in Financial Services in The Czech Republic. *J. Appl. Econ. Sci.* **2014**, *9*, 221–230.
32. Kawaguchi, T.; Ando, M.; Asami, K.; Okano, Y.; Fukuda, M.; Nakagawa, H.; Ibata, H.; Kozuki, T.; Endo, T.; Tamura, A.; et al. Randomized phase III trial of erlotinib versus docetaxel as second-or third-line therapy in patients with advanced non–small-cell lung cancer: Docetaxel and Erlotinib Lung Cancer Trial (DELTA). *J. Clin. Oncol.* **2014**, *32*, 1902–1908. [CrossRef]
33. Ali, Y.M.; Lynch, N.J.; Haleem, K.S.; Fujita, T.; Endo, Y.; Hansen, S.; Holmskov, U.; Takahashi, K.; Stahl, G.L.; Dudler, T.; et al. The lectin pathway of complement activation is a critical component of the innate immune response to pneumococcal infection. *PLoS Pathog.* **2012**, *8*, e1002793. [CrossRef] [PubMed]
34. Kumar, R. Performance measurement in dairy Supply chain management. *Indian J. Res.* **2014**, *3*, 100–101. [CrossRef]
35. Prakash, G.; Pant, R. Performance measurement of a dairy supply chain: A balance scorecard perspective. In Proceedings of the 2013 IEEE International Conference on Industrial Engineering and Engineering Management, Bangkok, Thailand, 10–13 December 2013; IEEE: Tianjin, China, 2013.
36. Kumar, A.; Kumar, R.; Rao, K. Enabling efficient supply chain in dairying using GIS: A case of private dairy industry in Andhra Pradesh state. *Indian J. Agric. Econ.* **2012**, *67*. [CrossRef]
37. Mudgal, R.K.; Shankar, R.; Talib, P.; Raj, T. Greening the supply chain practices: An Indian perspective of enablers' relationships. *Int. J. Adv. Oper. Manag.* **2009**, *1*, 151–176. [CrossRef]
38. Luthra, S.; Kumar, V.; Kumar, S.; Haleem, A. Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique: An Indian perspective. *J. Ind. Eng. Manag.* **2011**, *4*, 231–257. [CrossRef]
39. Ali, S.; Ahmad, N. Livestock Development and Poverty in Pakistan: Evidence from the Punjab Province. *J. Basic Appl. Sci. Res.* **2014**, *4*, 269–276.
40. Planning Commission. Annual Plan 2019–2020. 2019. Available online: https://www.pc.gov.pk/uploads/annualplan/AnnualPlan2019-20.pdf (accessed on 11 February 2021).
41. The State Bank of Pakistan. Economic Data of Pakistan. 2020. Available online: https://www.sbp.org.pk/ecodata/index2.asp (accessed on 26 March 2021).
42. Bar, F. Pakistan Human Development Report 2017 Team. 2018. Available online: https://www.undp.org/content/dam/pakistan/docs/HDR/NHDR_Summary%202017%20Final.pdf (accessed on 26 July 2020).
43. Iqbal, M.; Ma, J.; Ahmad, N.; Hussain, K.; Usmani, M.S.; Ahmad, M. Sustainable construction through energy management practices in developing economies: An analysis of barriers in the construction sector. *Environ. Sci. Pollut. Res.* **2021**, *28*, 34793–34823. [CrossRef]
44. Iqbal, M.; Ma, J.; Ahmad, N.; Hussain, K.; Usmani, M.S. Promoting sustainable construction through energy-efficient technologies: An analysis of promotional strategies using interpretive structural modeling. *Int. J. Environ. Sci. Technol.* **2021**, 1–24. [CrossRef]
45. Hussain, K.; He, Z.; Ahmad, N.; Iqbal, M. Green, lean, six sigma barriers at a glance: A case from the construction sector of Pakistan. *Build. Environ.* **2019**, *161*, 106225. [CrossRef]
46. Jharkharia, S.; Shankar, R. IT enablement of supply chains: Modeling the enablers. *Int. J. Product. Perform. Manag.* **2004**, *53*, 700–712. [CrossRef]
47. Sage, A.P. Methodology for Large-Scale Systems. 1977. Available online: https://books.google.com.pk/books/about/Methodology_for_Large_scale_Systems.html?id=Om5RAAAAMAAJ&redir_esc=y (accessed on 27 June 2021).
48. Iqbal, M.; Ma, J.; Ahmad, N.; Ullah, Z.; Ahmed, R.I. Uptake and Adoption of Sustainable Energy Technologies: Prioritizing Strategies to Overcome Barriers in the Construction Industry by Using an Integrated AHP-TOPSIS Approach. *Adv. Sustain. Syst.* **2021**, *5*, 2100026. [CrossRef]
49. Iqbal, M.; Ahmad, N.; Waqas, M.; Abrar, M. COVID-19 pandemic and construction industry: Impacts, emerging construction safety practices, and proposed crisis management. *Braz. J. Oper. Prod. Manag.* **2021**, *18*, 1–17. [CrossRef]
50. Toktaş-Palut, P.; Baylav, E.; Teoman, S.; Altunbey, M. The impact of barriers and benefits of e-procurement on its adoption decision: An empirical analysis. *Int. J. Prod. Econ.* **2014**, *158*, 77–90. [CrossRef]
51. Ali, S.S.; Kaur, R.; Jaramillo, A.B. An assessment of green supply chain framework in Indian automobile industry using interpretive structural modelling and its validation using MICMAC analysis. *Int. J. Serv. Oper. Manag.* **2018**, *30*, 318–356. [CrossRef]

52. Mishra, N.; Singh, A.; Rana, N.P.; Dwivedi, Y.K. Interpretive structural modelling and fuzzy MICMAC approaches for customer centric beef supply chain: Application of a big data technique. *Prod. Plan. Control* **2017**, *28*, 945–963. [CrossRef]
53. Khan, W.; Akhtar, A.; Ansari, S.A.; Dhamija, A. Enablers of halal food purchase among Muslim consumers in an emerging economy: An interpretive structural modeling approach. *Br. Food J.* **2020**, *122*, 2273–2287. [CrossRef]
54. Sonar, H.; Khanzode, V.; Akarte, M. Investigating additive manufacturing implementation factors using integrated ISM-MICMAC approach. *Rapid Prototyp. J.* **2020**, *26*, 1837–1851. [CrossRef]
55. Alkahtani, M.; Choudhary, A.; De, A.; Harding, J.A. A decision support system based on ontology and data mining to improve design using warranty data. *Comput. Ind. Eng.* **2019**, *128*, 1027–1039. [CrossRef]
56. Ray, A.; De, A.; Mondal, S.; Wang, J. Selection of best buyback strategy for original equipment manufacturer and independent remanufacturer–game theoretic approach. *Int. J. Prod. Res.* **2020**, 1–30. [CrossRef]
57. Goswami, M.; Daultani, Y.; De, A. Decision modeling and analysis in new product development considering supply chain uncertainties: A multi-functional expert based approach. *Expert Syst. Appl.* **2021**, *166*, 114016. [CrossRef]
58. Mukeshimana, M.C.; Zhao, Z.Y.; Ahmad, M.; Irfan, M. Analysis on barriers to biogas dissemination in Rwanda: AHP approach. *Renew. Energy* **2021**, *163*, 1127–1137. [CrossRef]
59. Raj, T.; Shankar, R.; Suhaib, M. An ISM approach for modelling the enablers of flexible manufacturing system: The case for India. *Int. J. Prod. Res.* **2008**, *46*, 6883–6912. [CrossRef]
60. Raj, A.; Rifkin, S.A.; Andersen, E.; Van Oudenaarden, A. Variability in gene expression underlies incomplete penetrance. *Nature* **2010**, *463*, 913–918. [CrossRef]
61. Kannan, G.; Pokharel, S.; Kumar, P.S. A hybrid approach using ISM and fuzzy TOPSIS for the selection of reverse logistics provider. *Resour. Conserv. Recycl.* **2009**, *54*, 28–36. [CrossRef]
62. Karamat, J.; Shurong, T.; Ahmad, N.; Afridi, S.; Khan, S.; Khan, N. Developing Sustainable Healthcare Systems in Developing Countries: Examining the Role of Barriers, Enablers and Drivers on Knowledge Management Adoption. *Sustainability* **2019**, *11*, 954. [CrossRef]
63. Ravi, V.; Shankar, R. Analysis of interactions among the barriers of reverse logistics. *Technol. Forecast. Soc. Chang.* **2005**, *72*, 1011–1029. [CrossRef]
64. Govindan, K.; Kannan, D.; Mathiyazhagan, K.; Jabbour, A.B.; Jabbour, C.J. Analysing green supply chain management practices in Brazil's electrical/electronics industry using interpretive structural modelling. *Int. J. Environ. Stud.* **2013**, *70*, 477–493. [CrossRef]
65. Ahmad, N.; Zhu, Y.; Hongli, L.; Karamat, J.; Waqas, M.; Mumtaz, S.M. Mapping the obstacles to brownfield redevelopment adoption in developing economies: Pakistani Perspective. *Land Use Policy* **2020**, *91*, 104374. [CrossRef]
66. Tan, T.; Chen, K.; Xue, F.; Lu, W. Barriers to Building Information Modeling (BIM) implementation in China's prefabricated construction: An interpretive structural modeling (ISM) approach. *J. Clean. Prod.* **2019**, *219*, 949–959. [CrossRef]
67. Malek, J.; Desai, T.N. Interpretive structural modelling based analysis of sustainable manufacturing enablers. *J. Clean. Prod.* **2019**, *238*, 117996. [CrossRef]
68. Godet, M. Introduction to la prospective: Seven key ideas and one scenario method. *Futures* **1986**, *18*, 134–157. [CrossRef]
69. Rao, P.; Holt, D. Do green supply chains lead to competitiveness and economic performance? *Int. J. Oper. Prod. Manag.* **2005**, *25*, 898–916. [CrossRef]
70. Totty, V.K.; Greenwood, S.L.; Bryant, R.H.; Edwards, G.R. Nitrogen partitioning and milk production of dairy cows grazing simple and diverse pastures. *J. Dairy Sci.* **2013**, *96*, 141–149. [CrossRef]
71. Olawumi, T.O.; Chan, D.W.; Wong, J.K.; Chan, A.P. Barriers to the integration of BIM and sustainability practices in construction projects: A Delphi survey of international experts. *J. Build. Eng.* **2018**, *20*, 60–71. [CrossRef]
72. Zhou, Q.; Han, R.; Li, T. A two-step dynamic inventory forecasting model for large manufacturing. In Proceedings of the 2015 IEEE 14th International Conference on Machine Learning and Applications (ICMLA), Miami, FL, USA, 9–11 December 2015; IEEE: Miami, FL, USA, 2015.
73. Brackbill, R.M.; Cameron, L.L.; Behrens, V. Prevalence of chronic diseases and impairments among US farmers, 1986–1990. *Am. J. Epidemiol.* **1994**, *139*, 1055–1065. [CrossRef] [PubMed]
74. Ahmad, M.; Iqbal, M.; Drissi, J.; Hassan, A. Modeling of Supply Chain Sustainability Enablers by Considering the Impact of COVID-19 on Developing Countries. *N. Am. Acad. Res. J.* **2021**, *4*, 264–279.
75. Marsalis, M.A.; Hagevoort, G.R.; Lauriault, L.M. *Survey of Silage Crop Nutritive Value in New Mexico and West Texas*; NM State University Cooperative Extension Service, College of Agricultural: Tucumcari, Mexico, 2012.
76. Gustavsson, J.; Cederberg, C.; Sonesson, U.; Van Otterdijk, R.; Meybeck, A. *Global Food Losses and Food Waste*; FAO: Rome, Italy, 2011.
77. Waqas, M.; Honggang, X.; Khan, S.A.; Ahmad, N.; Ullah, Z.; Iqbal, M. Impact of reverse logistics barriers on sustainable firm performance via reverse logistics practices. *LogForum* **2021**, *17*, 213–230.
78. Velázquez-Ordoñez, V.; Valladares-Carranza, B.; Tenorio-Borroto, E.; Talavera-Rojas, M.; Varela-Guerrero, J.A.; Acosta-Dibarrat, J.; Puigvert, F.; Grille, L.; Revello, Á.G.; Pareja, L. Microbial contamination in milk quality and health risk of the consumers of raw milk and dairy products. In *Nutrition in Health and Disease-Our Challenges Now and Forthcoming Time*; IntechOpen: London, UK, 2019.
79. Chamberlin, J.; Jayne, T.S. Unpacking the meaning of 'market access': Evidence from rural Kenya. *World Dev.* **2013**, *41*, 245–264. [CrossRef]

80. Muatip, K.; Sugiarto, M. Farmer Children's Willingness for Dairy Farming Succession in Banyumas Regency. *Anim. Prod.* **2016**, *18*, 118–124. [CrossRef]
81. Usmani, M.S.; Wang, J.; Ahmad, N.; Iqbal, M.; Ahmed, R.I. Mapping green technologies literature published between 1995 and 2019: A scientometric review from the perspective of the manufacturing industry. *Environ. Sci. Pollut. Res.* **2021**, *28*, 28848–28864. [CrossRef]