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Exploring the best policy scenario plan for the dairy supply chain: a DEMATEL approach

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Abstract

Purpose – This research primarily aims to find and analyse the interaction among success factors for improving the performance of Indonesia's dairy milk supply chain. Further, this research aims to formulate the right policies for improving the performance of the chain based on the success factor that belongs to cause groups.

Design/methodology/approach – The paper analyses 10 success factors for improving the performance of the Indonesian dairy supply chain with the decision-making trial and evaluation laboratory (DEMATEL) method and analyses the Delphi method to formulate the right policies for improving performance.

Findings – There are four important influencing factors that directly impact the overall system, i.e. the number of dairy cattle import, national milk demand, the total number of dairy farmers and the number of dairy cattle ownership or herd size. Several alternative policies have been designed by several experts according to the influencing factors, i.e. the government assists in the procurement of imported cattle, provides financial assistance to farmers in the form of low-interest financing, improves the partnership system between farmers and dairy cooperatives, provides a reward system for the farmers and increases the level of formality of contract between the farmers and cooperatives.

Research limitations/implications – Interrelationships of each success factor and the most important influencing success factors could not be generally determined because it depends on the point of view of the experts. Future research can apply the success factors proposed by this research to the different dairy milk supply chain. Then, this research used only nine experts for formulating alternative policies. Future research may repeat this method using multiple experts to justify the validity of the research. Moreover, this research only explored 21 success factors of the increase in the performance of the Indonesian dairy supply chain. Future research should consider not only the supply side and number of dairy cattle but also several success factors from the causal relationship diagram in the broader dairy milk supply chain.

Practical implications – This research provides essential insights for policymakers, as they have to understand and evaluate the success factors before formulating several alternative policies.

Social implications – The research has revealed that the right alternative policies can be designed, as the causal factor has been known.

Originality/value – This research contributes to applying a combination of causal relationship diagram of System Dynamic and DEMATEL method as a qualitative and quantitative method in one integrated way through performance dairy supply chain analysis. As a result, this research draws a

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policy for the dairy supply chain referring to the success factor as a cause for the low performance of the Indonesian dairy supply chain.

Keywords Data analysis, Supply chain management, Data mining, Causal relationship diagram, DEMATEL, Delphi, Dairy supply chain

Paper type Research paper

Introduction

There are two important challenges for Indonesia's dairy supply chain. The first challenge is the gap between supply and demand, and the second one is the lack of quality in milk being produced by the cattle (Moran and Morey, 2015). On the supply side, production from the dairy sector is changing rapidly. From 1985 to 2012, the production of domestic milk rose significantly from 0.2 million to approximately 1 million tonnes as the response of the Indonesian population grew (from 150 million to 261 million) along with the rise of milk consumption per capita (from 3 to 17 litres per capita per year). However, since 2011, the growth of the dairy sector has halted. Between 2012 and 2015, national milk production decreased from 1 million to 800,000 tonnes. This condition increases the percentage of dairy imports significantly. Between 2000 and 2018, dairy imports climbed from 1 million to 3.7 million tonnes of liquid milk equivalent. In this case, dairy imports can fulfil more than 81% of the national milk consumption, and only less than 19% of national milk consumption is fulfilled by national production. Recently, improvement was seen in the condition of the dairy sector as compared to that in the period of 2012–2015; national milk production has resumed growing since 2015, reaching 923,000 tonnes in 2017. However, the growth of national milk production is still far below the growth of national milk consumption. The average growth of national milk production is only 2% per year, compared to the growth of national milk consumption of 5% per year (Duteurtre *et al.*, 2018). On the demand side, Indonesia has the highest rate of growth in milk consumption among the Association of Southeast Asian Nations, at 4.8% per year over the period 2006–2010 (Morey, 2011). According to data from the Ministry of Agriculture, Indonesia's total national milk consumption was 3.8 million tonnes in 2016. Milk consumption increased steadily from 2.12 kg per capita per year for local cow milk and 9.72 kg per capita per year for imported cow milk in 2007 to 3.22 kg per capita per year for local milk and 13.62 kg per capita per year for imported milk, respectively, in 2016.

The government has tried to overcome the low growth of national milk production by launching a dairy development strategy called "Blueprint for the dairy sector 2013–2025". This blueprint has the following targets: the milk production should achieve 2.75 and 5.32 million tonnes in 2020 and 2025, respectively; the number of dairy cattle should reach 1.30 million heads, which will produce an average of 13.11 litres of milk per day in 2020 and the number of dairy cattle should reach 1.70 million heads, which will produce an average of 19.67 litres per day in 2025 (Wright and Meylinah, 2014). It is not easy to achieve the proposed target, as the dairy supply chain has many links that pass from the producer to retail to the final consumer (Shepherd and Flanders, 2008; Robinson, 2009; Simonson, 2009; Kumar and Nigmatullin, 2011). The dairy supply chain in Indonesia comprises several actors, i.e. dairy farmers as producers, cooperatives as collectors and handlers and milk processing industries as manufacturers, retailers and consumers (Utomo *et al.*, 2018). In general, the dairy supply chain begins when dairy farmers produce raw milk. Most of the raw milk is not distributed directly to industrial milk processing because most of the Indonesian dairy farmers are smallholders with restricted facilities. Dairy cooperatives help to collect and transport the dairy milk produced by the farmers. The cooperatives have a significant role for dairy farmers as milk is a highly perishable product that should be transported efficiently and refrigerated all the time (Glover *et al.*, 2014; Shukla and Jharkharia, 2013); this is prohibitively expensive for the smallholder farmers. During industrial milk processing, the raw milk is processed into consumable milk or other dairy products. Once processing has been completed, milk is transported to wholesale distributors. From the wholesale distributors, the milk goes to the retailers where it is purchased by consumers. This is a general flow of the formal dairy supply chain. In another case, the dairy milk produced by the farmer can be directly sold to milk traders, retailers (sweets shops, tea stalls and local hotels) and local customers (Nasir *et al.*, 2014).

The barriers to increasing national milk production begin with the condition of most dairy farmers in Indonesia, such as the lower efficiency and productivity at the farm level, no legally binding contract between the farmers and dairy cooperatives that ensures that a cooperative cannot fully control a farmer's decision in managing their farms and that the farmer cannot fully control the cooperative's decision (the cooperatives work like an independent company with smallholder farmers acting as its suppliers that have little influence on the cooperative's decisions) and low bargaining power of the cooperatives towards milk processing (Susanty *et al.*, 2019). The low productivity at the level of farms is related to the lack of knowledge owned by smallholder farmers. They tend to apply sub-optimal production methods for the feeding and nutrition of the cows and tend to use domestic cattle breeds that produce inferior yields (Moran and Morey, 2015). The smallholder farmers own a small number of cattle that prevent the farmers from achieving the economies of scale when running their farms. Most of the farmers only own two to three productive cattle. The cause of this condition can be seen from two factors. The first factor is the lack of capital owned by dairy farmers. The second factor is the 2012 government policy on reducing beef import (in the form of either imported feeder cattle or beef), leading to the slaughtering of cattle for meat consumption (Sirajuddin *et al.*, 2017). Seeking to take advantage of high beef prices, many farmers sold off dairy cows to slaughterhouses between 2011 and 2013, thereby exacerbating the shortfall in milk production. The condition is even worse with an increase of animal feed prices that result to the farmers complaining about the price they receive for milk barely—if at all—covers the cost of production (Moran and Morey, 2015). This condition makes the farmers only receive the small profit for milk, which can trigger the farmers to shift their business to other fields of work as they become uninterested in farming. In the end, this will reduce the number of farmers.

From the explanation about the structure of dairy supply chain and the problems faced by this chain, it is quite clear that the effort to increase the performance of Indonesia's dairy supply chain can be made by giving attention to several success factors; for example, placing the highest priority on increasing the number of dairy farmers and placing more emphasis on increasing per-cow milk yields, increasing the population of dairy farmers and the number of dairy cattle; increasing the good relationship between dairy farmers, cooperatives, industrial milk processors and increasing the profit gained by the farmers. Mangla *et al.* (2014) proposed that to attain success in the food supply chain, it is necessary for policymakers to focus on success factors that are important for improving its performance. Moreover, those several success factors that contribute to improving the supply chain's performance may be interrelated, and some of them could also be affected by others. Therefore, this research primarily aims at finding and analysing the interaction among the success factors for improving the performance of Indonesia's dairy milk supply chain by making use of the decision-making trial and evaluation laboratory (DEMATEL) method. This research also aims at formulating the right policies for improving the performance based on success factors that belong to the cause group. In this research, initially, 21 success factors were diagnosed through the causal relationship diagram that depicted the relationship among several factors that contributed to the increased supply chain performance from two perspectives, i.e. dairy milk supply and dairy cattle population. However, only 10 factors were finalised for further analysis by DEMATEL based on the result of content validity process (see the "Perspectives, Success Factors, and the Validation Process" section) from 20 experts who are the representatives of the six dairy cooperatives in three different regions located in West Java, Central Java and East Java Provinces (see the "Data Collection" section for the requirements and the number of representatives from each dairy cooperative that was sampled in this research and the name and region of the dairy cooperatives). The findings from this research will significantly improve the understanding of the nature of interactions among success factors for improving the performance of Indonesian dairy milk supply chain, so the policymakers can be more precise in making policy interventions by understanding which of these factors have the greatest influence.

Literature review

Previous research about the dairy supply chain can be traced back to several authors. According to their topics, these research can be divided into four groups:

(1) Research on the structure of relationships in the dairy supply chain;

(2) Research on competitiveness and strategies in the dairy supply chain;

(3) Research on risks in the dairy supply chain; and

(4) Research on performance measurement of the dairy supply chain.

Structure of the relationship between actors in the dairy supply chain

Generally, the dairy supply chain comprises five main actors, namely, raw milk supplier/dairy farmer, dairy cooperatives, the milk processing plant, the retailer and the customer. Vertical integration and coordination become something interesting in the relationship between these actors because they typically have different characteristics, objectives and interests (Susanty *et al.*, 2017). The coordination among the actors in the supply chain is undeniably important in determining the performance of the supply chain, even if the actors have different objectives and interests (Ning *et al.*, 2008). The coordination among actors in the dairy supply chain is also undeniably important in solving economic problems felt by small-scale farmers when dealing with the other actors (Ziad *et al.*, 2019). For example, small-scale farmers in rural Punjab are not appropriately coordinated, thereby having low herd size and low bargaining power. Prices offered to the small-scale farmers and large-scale farmers by their respective producers indicate variations. The large farmers get a high price per litre of milk, whereas small-scale farmers get a low price per litre of milk from middlemen, as they have middlemen as their last resort. There is also a lack of government support for small-scale farmers.

Research on vertical integration and collaboration between raw milk suppliers/dairy farmers and milk processing plants can be found in Federico *et al.* (2011), Pinior *et al.* (2011), Dries *et al.* (2014) and Lemma (2015). Federico *et al.* (2011) shed some light on the potential role of vertical integration to the increase of the competitiveness of British dairy farmers. The vertical integration strategy may let the dairy farmers decrease the buying power of the large processor within the supply chain. In the German dairy supply chain, vertical integration resulted in branded processing companies monitoring all stages of the supply chain (Pinior *et al.*, 2011). Dries *et al.* (2014) evaluated the vertical coordination in the Armenian dairy sector, specifically, farm–milk processor relationships and the provision and impact of supplier support measures as part of these relationships. In this case, the supplier support programme is positively determined by four factors, namely, the initial capital of the supplier, the degree of exclusivity of the buyer–supplier relationship, foreign ownership of the buyer and co-operation between suppliers. Moreover, according to Lemma (2015), there are four factors of coordination in the milk and dairy industries in Ethiopia, namely, non-price coordination, relationship, price coordination and product development decision; each type of coordination has several major influencing factors.

Then, research on the collaboration between raw milk suppliers/dairy farmers and dairy cooperatives can be found in Kumar *et al.* (2011), Gupta and Roy (2012), Susanty *et al.* (2017) and Mahida *et al.* (2018). Gupta and Roy (2012) investigated the issue of selection or participation of dairy farmers in a cooperative and used descriptive and regression analysis to assess the benefits received by dairy farmers from joining with the cooperative. The source of this higher profit comes not from higher prices but cheaper inputs provided by the cooperative, including feed and veterinary services. In Gujarat, a dairy cooperative plays the same role. Dairy cooperatives play an important role in nurturing, strengthening and providing a livelihood to rural households and serve as a prominent organisation for providing inputs and resource services. This condition makes the dairy cooperative's member farmers more technically efficient than non-members Mahida *et al.* (2018). The dairy cooperative also assists the dairy farmer to integrate with modern formal milk marketing, as the dairy cooperative can act as the milk collector in the villages (Kumar *et al.*, 2011). Although the dairy cooperative plays a significant role for the farmers, it is not easy to make dairy farmers loyal to their dairy cooperative because there is no formal contract between the two parties. According to Susanty *et al.* (2017), the loyalty of the dairy farmers to the cooperatives depends on the level of collaborative communication, power dependence, price satisfaction and trust. In this case, although not proven in all surveyed regions, collaborative communication, price dependence and trust have a positive significant effect on the loyalty of the dairy farmers, whereas power dependence has a negative significant effect on the loyalty of dairy farmers. The loyal dairy farmers can give a positive effect on the cooperative, as they can deliver good quality milk and in quantity.

Competitiveness and strategies in the dairy supply chain

The research about the competitiveness and strategies in the dairy supply chain can be found in Issar *et al.* (2003), Pathusi and Kume (2014) and Beber *et al.* (2019). According to Issar *et al.* (2003), transforming the Australian dairy sector should be done through deregulation, supermarket strategies, food safety, supply chain integration, innovation, environmental sustainability and rationalisation of the supply base. In the case of the dairy sector in Tirana, according to Pathusi and Kume (2014), the competitiveness of the dairy sector should be ensured by improving the co-operation horizontally, vertically and laterally and by more effective policymaking. In Southern Brazil, according to Beber *et al.* (2019), some strategies should be executed to overcome the barriers to competitiveness of the dairy sector, such as missing the professionalism, formal agreements, investments in marketing and research, technology, development and innovation, technical assistance, high transport and transaction costs, idle capacities and fraud.

Risk in the supply chain

As the dairy supply chain involves many actors, risks may arise from any component within its supply chain. Besides that, no matter how robust the supply chain is, risks and uncertainties cannot be ruled out and require attention; if unattended, they will affect the supply chain adversely in many ways (Simchi-Levi *et al.*, 2008). On risk in the supply chain, we can find the research conducted by Mishra and Shekhar (2011), Nasir *et al.* (2014), Zubair and Mufti (2015), Daud *et al.* (2015), Liu and Arthanari (2016), Chari and Ngcamu (2017), Prakash *et al.* (2017) and Garvey *et al.* (2018).

Mishra and Shekhar (2011) found 14 risks in the dairy supply chain, and seven of them belong to high risk, namely, low milking cattle, illiteracy of the milk producers, non-remunerative price of milk, logistical risks, hazard risks, demand unpredictability and lack of product reliability. Nasir *et al.* (2014) used a different approach to identify the risk in the Bangladesh dairy supply chain. According to Nasir *et al.* (2014), risk in the Bangladesh dairy supply chain can be grouped into three aspects: economic, social and environmental. Then, each aspect has several risk factors. Financial risk and technological shortage risk factors belong to the economic aspect. Human resource risk, government policy and support, political risk, mismanagement and unethical behaviour of employees are risk factors belonging to social risk, whereas natural risk factor belongs to the environmental aspect. Moreover, each risk factor has several risk variables. Zubair and Mufti (2015) tried to identify and assess the supply chain risks in the dairy products sector in Pakistan. Using the risk breakdown structure approach, Zubair and Mufti (2015) divided supply chain risks into five major categories and 21 components.

Daud *et al.* (2015) tried to find the sources of risks that may appear in the existing dairy milk supply chain in a milk-producing area in West Java Province (Indonesia) and their implication on the production behaviour of the supply chain. The result of their research was a few most significant risks among many other risks, namely quality of the milking animal, feed availability, milk handling practices, milk bulking practices and milk transportation. Liu and Arthanari (2016) modelled the risk in the dairy supply chain through system dynamics. Chari and Ngcamu (2017) investigated the impact of the overall disaster risk index (natural disaster risks, political and economic and the meltdown in the country) on the performance of the dairy supply chain in Zimbabwe. The performance of the dairy supply chain was measured using four proxies: job losses, food security, business growth, and milk productivity. The findings computed through regression analysis indicated that an overall index of disaster risks negatively affected the dairy supply chain performance.

Ghosh *et al.* (2014) and Prakash *et al.* (2017) used the same method – interpretive structural modelling (ISM) – to understand the condition of dynamics between various risks in the dairy supply chain. Although they used the same method, Ghosh *et al.* (2014) and Prakash *et al.* (2017) found different results. In this case, Ghosh *et al.* (2014) found that training facilities and education programmes for staff and dairy farmers are two important risks to mitigate, whereas Prakash *et al.* (2017) found that the supplier side, market risks, and process risks are three important risks to mitigate. Garvey *et al.* (2018) did not list all of the risks in the dairy supply chain. Using regression analysis, they tried to test the relationship between the promotion or prevention focus strategy, which is indicated by the risk of decision making (independent variable), planned expansion strategies (intervening variables) and total milk production (dependent variable). The results indicate that promotion focus among farmers has an indirect effect on farm expansion, through planning strategies that incur greater risk to the farm enterprise.

Performance measurement of the dairy supply chain

Research about the important drivers or indicators or factors and the measurement tool for assessing the performance of the dairy supply chain can be found in Prakash and Pant

(2013), Kumar (2014), Kumar and Mohan (2014), Okano *et al.* (2014), Mor *et al.* (2017, 2018), Susanty *et al.* (2018), Susanty *et al.* (2019), Dizyee *et al.* (2019) and Bórawski *et al.* (2020).

Prakash and Pant (2013) and Susanty *et al.* (2018) used key performance indicators of four perspectives of the Balanced Scorecard (internal business process, customers, finance and learning and growth) to assess the performance of the dairy supply chain. Different from Prakash and Pant (2013), specifically, Susanty *et al.* (2018) assessed the performance of the relationship among farmers, dairy cooperatives and industrial milk processors. Moreover, Susanty *et al.* (2018) used importance-performance analysis to identify the indicators that are most in need of improvement and used the strength, weakness, opportunity and threat analysis to formulate strategic planning for improving the condition of those indicators. Kumar (2014) and Kumar and Mohan (2014) proposed the framework that was based on some indicators (information and communication technology, supply chain manufacturing practices, warehousing management system, transportation and distribution management, inventory management system, supplier relationship practices and customer relationship management) to assess the performance of dairy supply chain practices. Thereafter, the performance of dairy supply chain practices would have an impact on marketing and operational performance and flexibility.

Kumar and Mohan (2014) conducted further research from that by Kumar (2014). In a more complex conceptual model, Kumar and Mohan (2014) not only saw the impact of the performance of dairy supply chain practices but also the antecedent factors. Moreover, Kumar and Mohan (2014) saw not only the impact of the performance of dairy supply chain practices in the context of marketing and operational performance, and flexibility but also customer satisfaction. Okano *et al.* (2014) identified some indicators (source of income, farming system, milking system, technological resource, administration methodology, investment and breeding or nutritional improvement) to classify the performance level of the producers in the dairy milk supply chain. According to Mor *et al.* (2018), eight critical factors (CFs) contributed to low productivity of the northern region of the Indian dairy supply chain, namely, water and steam wastages, poor infrastructure, cold chain logistics, and transport facilities, poor employee welfare schemes, poor infrastructure at milk collection points, more waiting time at the milk packaging line, traceability of quality issues, operator's negligence and lack of automation in the plant.

Using analytic hierarchy process analysis, Mor *et al.* (2018) identified that the major CFs causing low productivity in the dairy supply chain are poor logistics and transportation facilities. In a more recent research, Mor *et al.* (2018) identified the contribution of 11 performance indicators (PIs) to the Indian dairy industry sector, namely, effective product marketing, effective quality management, supplier relationship management, traceability systems, brand management and featured products, effective cold chain infrastructure, information-technology enabled support system, milk wastages management, responsiveness in shipment accuracy, support for technological innovations and production operations management. Then, using ISM methodology, Mor *et al.* (2018) identified PIs that make the most contribution to the Indian dairy industry sector, namely, the information-technology-enabled support system, brand management and featured products, responsiveness in shipment accuracy and milk wastage management. Susanty *et al.* (2019) and Dizyee *et al.* (2019) used system dynamic methodology to simulate the causal relationship between several factors that contributed to the performance of the dairy supply chain in Indonesia and Kilosa, a district in Tanzania, respectively. In this case, Susanty *et al.* (2019) proposed five policy scenarios, i.e. dairy cattle import, operational assistance for dairy cooperatives, dairy farmer training, operational assistance and dairy farmer training and the combined scenario, whereas Dizyee *et al.* (2019) proposed two scenarios, namely, artificial insemination (AI) and producers' access to distant markets through a dairy market hub. Susanty *et al.* (2019) found the combined scenario to be the best among the five proposed scenarios. This scenario can not only increase the number of dairy cattle ownership but also increase the profit of the farmers because the training enables the farmers to manage their farms better. Dizyee *et al.* (2019) found that the scenario AI hurts the income of farmers in the short (1-year) and medium (5-year) term. This is due to high AI costs. However, in the long term (5+ years), the income of farmers significantly increases (by, on average, 7% per year). More recently, Bórawski *et al.* (2020) identify some factors that contributed to a cow's milk production in the European Union (EU). Then, using the multivariate regression model, Bórawski *et al.* (2020) tested the relationship between those proposed factors with milk production in the EU. Domestic product, final household consumption expenditure (current prices, in million euro) and population (number) are important factors of increasing milk production in the EU.

Based on those literature reviews, it can be seen that despite the growing number of researches considering the structure of the relationship among dairy supply chain, competitiveness and strategies in the dairy supply chain, risk in the dairy supply chain and measurement or assessment of the performance of the dairy supply chain based on some indicators/drivers/factors, the research literature regarding interactions among factors that are crucial for improving the performance of the chain is still limited.

Method of Research

Data collection

A survey in the form of questionnaire distribution was conducted in 2019 to collect data for this research. This research used three types of questionnaires, namely, validation questionnaire, DEMATEL questionnaire and Delphi questionnaire. The validation questionnaire was used for the content validity process. This questionnaire was used to rate the success factor on a 4-point Likert scale, from 1 "not relevant" to 4 "very relevant". The DEMATEL questionnaire was used for the DEMATEL method. This questionnaire was used to determine the degree and direction of interactive influence between validated success factors and used four levels of scale, from 0 "no influence" to 4 "very high influence" (Chien *et al.*, 2014). Then, the Delphi questionnaire was used for the Delphi method. This questionnaire consisted of two type questions. First, a semi-structured (or open-ended) question about proposed policies related to the success factors. A semi-structured question was the first round of Delphi interview questions and asked respondents to answer in their own words: "what are the proposed policies for the success factor X?"; "why you propose this policy for the success factor X?" These questions allowed the respondents to express their point of view and to describe situations. Second, a well-structured questionnaire with a 5-Likert Scale. The second round of the Delphi questionnaire was developed based on the respondents' responses to the first round of Delphi interview questions. The second-round questionnaire was distributed to the same respondents and they were asked to rate, from 1 "not a priority" to 5 "essential" (Skinner *et al.*, 2015; Tilakasiri, 2015; Knight *et al.*, 2018).

All of these questionnaires were mailed to the respondents before a meeting. The population of interest to fill out that questionnaire and conduct the short personal interview was the representative of the dairy cooperative and the representative of the Association of Indonesian Dairy Cooperatives located in three regions at three provinces (Bandung, West Java Province; Boyolali, Central Java and Malang, East Java Province). These provinces have a significant contribution to national milk production. The East Java Province accounts for 57.1% of the dairy supply chain in

Indonesia milk production, whereas West Java and Central Java account for 29.2% and 11.4%, respectively. The centre of dairy milk production in West Java Province is Bandung Regency. The centre of dairy milk production in Central Java Province is Semarang and Boyolali Regencies, and the centre of dairy milk production in East Java Province is Pasuruan and Malang (Morey, 2011).

A purposive sample was employed with quotas for selecting the dairy cooperative in three regions and for selecting the respondents of the research (the representative of a selected dairy cooperative and Association of Indonesian Dairy Cooperatives). The selection criteria for the dairy cooperative were statistical data of the average milk production per day, and we selected the dairy cooperative with the highest dairy milk production per day in each region (Bandung, Boyolali, and Malang). Moreover, the selected dairy cooperative should be a member of the Association of Indonesian Dairy Cooperatives in a certain region:

- In Bandung, the highest dairy milk production per day is produced by North Bandung Cattle Breeder Cooperative (Koperasi Peternak Sapi Bandung Utara/KPSBU). KPSBU produces around 145,959 litres of dairy milk per day or approximately 38.51% of total daily milk production from dairy cooperatives in West Java Province, which is incorporated with West Java Association of Indonesian Dairy Cooperatives (Gabungan Koperasi Susu Indonesia Jawa Barat/GKSI Jawa Barat).
- In Boyolali, the highest dairy milk production per day is produced by Mojosongo Dairy Cooperative. This cooperative produces around 32,304 litres of dairy milk per day or approximately 23.75% of total daily milk production from dairy cooperatives in Central Java Province, which is incorporated with the Central Java Association of Indonesian Dairy Cooperatives (Gabungan Koperasi Susu Indonesia Jawa Tengah/GKSI Jawa Tengah).
- In Malang, the highest dairy milk production per day is produced by SAE dairy cooperatives. This cooperative produces around 82,257 litres of dairy milk per day or approximately 20.49% of total daily milk production from dairy cooperatives in East Java Province, which is incorporated with the East Java Association of Indonesian Dairy Cooperatives (Gabungan Koperasi Susu Indonesia Jawa Timur/GKSI Jawa Timur).

Then, this research used years of working experience and professional recognition as criteria for choosing the representatives. The representatives had to have worked or have experience in the dairy industry for at least 5 years. Moreover, the representatives had to have occupied at least a managerial position. The validation questionnaire and DEMATEL questionnaire were distributed to 20 experts who were representatives from several dairy cooperatives and the Association of Indonesian Dairy Cooperatives. In detail, the three types of questionnaires were distributed to seven experts in Bandung, who were representatives of North Bandung Cattle Breeder Cooperative and the West Java Association of Indonesian Dairy Cooperatives; five experts in Boyolali, who were representatives of the Mojosongo Dairy Cooperative and the Central Java Association of Indonesian Dairy Cooperatives and eight experts in Malang, who were representatives of the SAE Dairy Cooperative and the East Java Association of Indonesian Dairy Cooperatives. The Delphi questionnaire only distributed to nine experts (three experts from dairy cooperatives and the Association of Indonesian Dairy Cooperatives in each region).

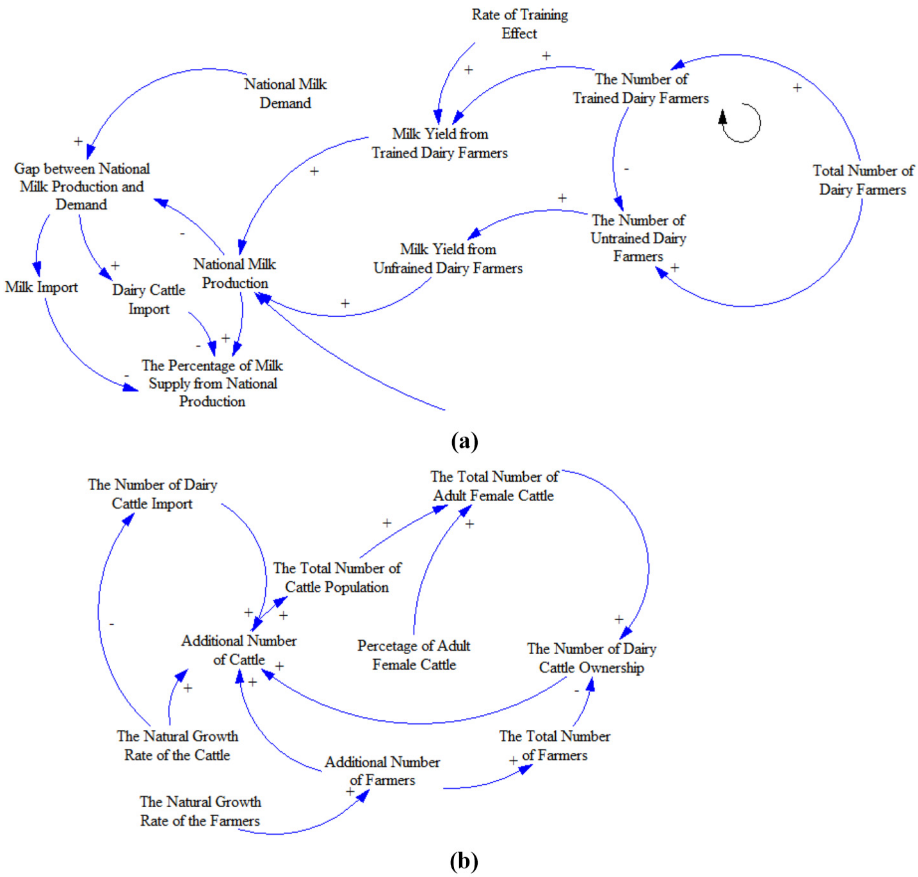
Then, related to the number of experts used for a group's decision-making, determining the number of experts has always been inconsistent. There was no related literature that demonstrated specifically the appropriate number of experts for study reliability and validity today (Lee *et al.*, 2013; Si *et al.*, 2018). According to Teng (2002), 5–15 experts are an appropriate number for a group's decision-making. However, in the content validation process, according to Strickland *et al.* (2013), Kong (2011) and Umar and Su-Lyn (2011), the number of experts should not be less than two but not more than six. Other researchers, such as DeVon *et al.* (2007), recommended the use of seven or more experts for the content validity process, whereas Alias *et al.* (2019) recommended the use of 3–10 experts. Thus, based on this explanation, we can judge that the number of experts used in this research is somewhat enough, as the number of expert panels in each region is between five and eight persons.

Perspectives, success factors and the validation process

Referring to the previous research conducted by Susanty *et al.* (2018, 2019), the success factor for improving the performance of the Indonesian dairy milk supply chain was diagnosed through the causal relationship diagram. It depicted the relationship between several factors that contributed to the supply chain's performance. Graphically, those causal relationships can be seen in Figure 1.

According to Figure 1, the success factors identified in this research can be categorised into two perspectives, namely, dairy milk supply and dairy cattle population. The success factors that belong to dairy milk supply are the percentage of milk supply from national production, the total number of dairy farmers, the number of trained dairy farmers, the number of untrained dairy farmers, milk yield resulted from untrained dairy farmers, milk yield resulted from trained farmers, rate of training effect, national milk demand, national milk production, the amount of milk import and the gap between national milk production and demand. The success factors belong to dairy cattle population are the natural growth rate of dairy farmers, the additional number of farmers, the total number of the farmers, the natural growth rate of the dairy cattle, the number of dairy cattle import, the total number of the cattle, the additional number of the cattle, the percentage of adult female cattle, the total number of adult female cattle, the number of dairy cattle ownership. Overall, there were 21 success factors.

After all of the possible success factors generated from the causal loop diagram, content validity was undertaken to make sure that the success factor was appropriate and relevant to the research purpose. Content validity indicates that the content reflects a complete range of the factors or indicators or attributes under study (DeVon *et al.*, 2007). The content validity of relevant factors to the objective of this research was estimated through five to eight experts' opinions in three different regencies at three different provinces (Bandung Regency for West Java Province, Semarang Regency for Central Java Province and Malang Regency for East Java Province). In this case, the experts who were representative of the management were asked to fill the validation questionnaire with a four-point Likert scale independently (1 = not relevant, 2 = somewhat relevant, 3 = relevant, 4 = very relevant). Then, the Content Validity Index (CVI) was used to estimate the validity of the items (Lynn, 1986). The value of CVI for each item computed as the number of experts giving a rating of either 3 or 4 for that item divided by the number of experts, i.e. the proportion in agreement about relevance. For example, an item rated as "quite" or "very" relevant by four out of five judges would have the value CVI of 0.80. Lynn (1986) provided widely cited guidelines for what an acceptable value of CVI should be concerning the number of



Source: Susanty *et al.* (2018, 2019)

Figure 1.
Causal relationship diagram between numbers of factors that contributed to the dairy milk supply (a) and causal relationship diagram between numbers of factors that contributed to the dairy cattle population (b)

experts. She advocated that when there are five or fewer experts, the CVI must be 1.00: that is, all experts must agree that the item is content valid. When there are more than five experts, there can be a modest amount of disagreement (e.g. when there are at least six experts, CVI must be at least 0.83, reflecting one disagreement; when there are six to eight experts, CVI must at least 0.83 and when there are at least nine experts, CVI must at least 0.73).

This research only retained success factors that were valid in all surveyed regencies. For example, the first success factor (the percentage of milk supply from national production) was retained to be processed because this factor is valid according to not only the experts located in Bandung but also the experts located in Boyolali and Malang. In detail, the result of the content validation process of 21 success factors can be seen in Table 1.

Then, after the content validity assessment by 20 experts, only 10 factors were retained as the success factors for improving the performance of Indonesia's dairy milk supply from

No.	The success factors	The value of CVI from Bandung, West Java[a]	The value of CVI from Boyolali, Central Java[b]	The value of CVI from Malang, East Java[c]	Conclusion
1	The percentage of milk supply from national production	1.00	1.00	1.00	Valid
2	The number of trained dairy farmers	1.00	1.00	1.00	Valid
3	The total number of dairy farmers	1.00	1.00	1.00	Valid
4	The number of untrained dairy farmers	0.29	0.40	0.50	Not valid
5	National milk production	1.00	1.00	1.00	Valid
6	The amount of milk import	1.00	1.00	0.88	Valid
7	Milk yield resulted from untrained dairy farmers	0.14	0.40	0.38	Not valid
8	Milk yield resulted from trained farmers	0.57	1.00	0.38	Not valid
9	Rate of training effect	0.29	0.20	0.50	Not valid
10	Gap between national milk production and demand	0.29	0.00	0.38	Not valid
11	National milk demand	1.00	1.00	1.00	Valid
12	The number of dairy cattle ownership	1.00	1.00	1.00	Valid
13	The total number of the cattle	0.43	0.60	0.63	Not valid
14	The additional number of the cattle	0.43	0.40	0.25	Not valid
15	The number of dairy cattle import	1.00	1.00	1.00	Valid
16	The total number of adult female cattle	1.00	1.00	1.00	Valid
17	The total number of the farmers	0.29	0.60	0.13	Not valid
18	The natural growth rate of dairy farmers	0.14	0.40	0.25	Not valid
19	The additional number of farmers	1.00	0.60	0.63	Not valid
20	The natural growth rate of the dairy cattle	1.00	1.00	1.00	Valid
21	The percentage of adult female cattle	0.14	0.60	0.38	Not valid

Notes: [a]Seven experts, CVI must at least 0.83; [b]five experts, CVI must be 1.00; [c]eight experts, CVI must at least 0.73

Table 1. The result of content validity

the perspective of dairy milk supply and dairy cattle ownership. The 10 success factors were the percentage of milk supply from national production (FAC1), the number of dairy cattle ownership by each farmer (FAC2), the number of trained dairy farmers (FAC3), the total number of dairy farmers (FAC4), national milk production (FAC5), the total number of adult female cattle (FAC6), the amount of milk import (FAC7), the number of dairy cattle import (FAC8), national milk demand (FAC9) and the natural growth rate of the dairy cattle (FAC10).

Data analysis
There were three methods used in this research, namely, content validity, DEMATEL method and Delphi method. Content validity was used to know the degree to which success factors are relevant to increase dairy supply chain performance. Then, the DEMATEL method was used to analyse the 10 success factors for improving the performance of the Indonesian dairy supply chain, and the Delphi method was used to formulate the right policies for improving the performance of the supply chain.

This research used the DEMATEL method because it is a sophisticated method for visualising the structure of complicated causal relationships among complex factors through matrices or digraphs (Gabus and Fontela, 1972, 1973). The DEMATEL method can check the interdependence among factors and assistance in the development of a map to reflect relative relationships within them and can be used for investigating and solving complicated and intertwined problems. This method not only converts the interdependency relationships into a cause and effect group using matrices but also finds the CFs of a complex structure system with the help of an impact relation diagram (Si *et al.*, 2018). There were five steps of processing the data with the DEMATEL method. First, the average direct influence matrix a_{ij} was generated. Second, the normalised initial direct-relation matrix was calculated. Third, the normalised indirect-influence matrix was calculated. Fourth, the total-influence matrix was constructed by summing the direct effects and all of the indirect effects. Fifth, the total degree to which a specific factor exerted influence on and was influenced by other factors was found and the degree to which a factor affects and was affected by other factors. To this end, in this step, it is possible to determine the hierarchy or structure of the factors (Mehregan *et al.*, 2012).

Last, the Delphi method was used to formulate the policy recommendation. This research used the Delphi method because this method can bring geographically dispersed panel experts together, overcoming spatial limitations (Skinner *et al.*, 2015). The Delphi method used several rounds to distribute the questionnaire related to proposed policies. In the first round, the semi-structured questions were distributed to the experts to identify some proposed policies related to the success factors for improving the performance of the dairy supply chain. Then, based on the information gathered from the first round, close-ended questions were used for the second and subsequent rounds. These questionnaires are looking for the quantification of the level of priority of the proposed policy based on earlier findings, typically through a rating or ranking technique with a five-point Likert scale (1 = not a priority to 5 = essential). A round in the Delphi method would be stopped if the consensus has been reached (Skinner *et al.*, 2015).

Graphically, the flow diagram of research steps used in this research is presented in Figure 2.

Result and Discussion

The result of data processing with the DEMATEL method
First step. The first step in DEMATEL is finding the matrix of the average value of a_{ij}. To evaluate the relationships between n factors (F1, F2, . . ., Fn) in a system, assume that l experts in a group discussion (E1, E2, . . ., El) are requested to specify the direct influence that factor Fi has on factor Fj, using an integer scale of "no influence (0)," "low influence (1)," "medium influence (2)," "high influence (3)," and "very high influence (4)". The average value of a_{ij} from H respondents was calculated using

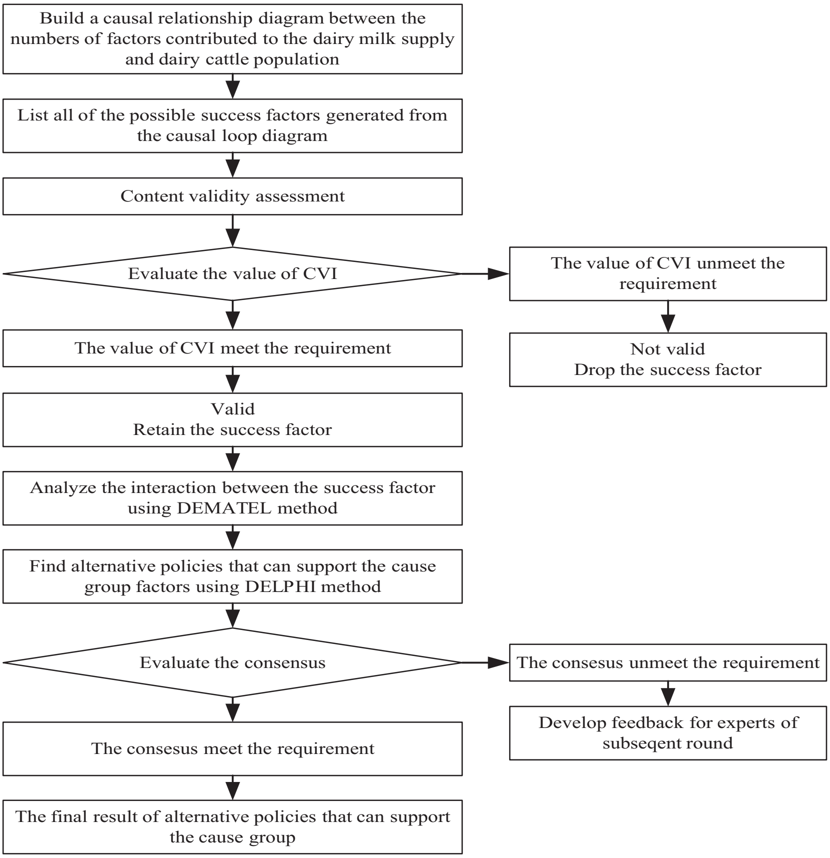


Figure 2.
Flow diagram of research steps

equation (1). The average matrix A = [a_{ij}] is also called the initial direct-relationship matrix (Lin and Lin, 2008).

$$a_{ij} = \frac{1}{H}\sum_{k=1}^{H} x_{ij}^{k} \tag{1}$$

In equation (1), a_{ij} = the average value of the binary relations and the degree of influence of factor i to factor j,

H = the number of experts.

x = the value of the binary relationship and degree of relationship of factor i to factor j according to each expert

The average matrix A from 20 respondents that consists of 10 success factor is presented in equation (1) (Average Input Direct-Relation of Success Factor).

$$
A = \begin{array}{cccccccccc|c}
FAC1 & FAC2 & FAC3 & FAC4 & FAC5 & FAC6 & FAC7 & FAC8 & FAC9 & FAC10 & \\
0 & 0,117 & 0,067 & 0,063 & 0,088 & 0,118 & 0,126 & 0,120 & 0,096 & 0,062 & FAC1 \\
0,107 & 0,000 & 0,061 & 0,113 & 0,133 & 0,155 & 0,082 & 0,069 & 0,106 & 0,179 & FAC2 \\
0,117 & 0,073 & 0,000 & 0,051 & 0,124 & 0,066 & 0,017 & 0,032 & 0,059 & 0,044 & FAC3 \\
0,104 & 0,159 & 0,079 & 0,000 & 0,087 & 0,111 & 0,090 & 0,062 & 0,057 & 0,047 & FAC4 \\
0,180 & 0,108 & 0,108 & 0,098 & 0,000 & 0,115 & 0,136 & 0,052 & 0,086 & 0,039 & FAC5 \\
0,111 & 0,120 & 0,072 & 0,094 & 0,138 & 0,000 & 0,117 & 0,094 & 0,122 & 0,038 & FAC6 \\
0,113 & 0,084 & 0,060 & 0,070 & 0,100 & 0,101 & 0,000 & 0,088 & 0,077 & 0,054 & FAC7 \\
0,107 & 0,098 & 0,092 & 0,067 & 0,108 & 0,132 & 0,104 & 0,000 & 0,112 & 0,181 & FAC8 \\
0,161 & 0,097 & 0,085 & 0,082 & 0,119 & 0,124 & 0,111 & 0,093 & 0,000 & 0,027 & FAC9 \\
0,167 & 0,072 & 0,076 & 0,087 & 0,058 & 0,035 & 0,044 & 0,066 & 0,024 & 0 & FAC10
\end{array}
$$

Second step. The second step is calculation of the normalised initial direct-relation matrix (D) using this equation (2) (Lin and Lin, 2008):

$$
D = S \times A;\ S = \min\left[\frac{1}{\max 1 \le i \le n \sum_{j=1}^{n} |a_{ij}|}, \frac{1}{\max 1 \le j \le n \sum_{i=1}^{n} |a_{ij}|}\right] = 0,8574. \quad (2)
$$

The sum of each j row of matrix A indicates the total direct effect that factor i has on the other factors; thus, the amount of max $\sum_{j=1}^{n} |a_{ij}|$ indicates the total direct effect that a factor with maximum direct effect has on the other factors. Additionally, because the sum of each i column in matrix A represents the total direct effect of the other factors on factor i, the amount of $\sum_{i=1}^{n} |a_{ij}|$ indicates the total direct effects that the factor that is most affected by other factors receives. The normalised initial direct-relation matrix (D) can be seen in Average Input Direct-Relation of Success Factor.

Third step. The third step is calculation of the indirect influence of the matrix with this the equation (3) (Lin and Lin, 2008). It should be noted that in some cases, success factors do not have a direct effect on one another, and inevitably, we need to calculate an indirect effects so that we may finally demonstrate the effect of each success factor on other success factors:

$$
D = \begin{array}{cccccccccc|c}
FAC1 & FAC2 & FAC3 & FAC4 & FAC5 & FAC6 & FAC7 & FAC8 & FAC9 & FAC10 & \\
0,000 & 0,101 & 0,058 & 0,054 & 0,075 & 0,101 & 0,108 & 0,103 & 0,082 & 0,053 & FAC1 \\
0,092 & 0,000 & 0,052 & 0,096 & 0,114 & 0,133 & 0,070 & 0,059 & 0,091 & 0,153 & FAC2 \\
0,101 & 0,063 & 0,000 & 0,044 & 0,106 & 0,057 & 0,015 & 0,027 & 0,050 & 0,038 & FAC3 \\
0,089 & 0,136 & 0,068 & 0,000 & 0,074 & 0,095 & 0,077 & 0,053 & 0,049 & 0,040 & FAC4 \\
0,154 & 0,092 & 0,092 & 0,084 & 0,000 & 0,099 & 0,116 & 0,045 & 0,073 & 0,034 & FAC5 \\
0,095 & 0,103 & 0,062 & 0,081 & 0,118 & 0,000 & 0,101 & 0,081 & 0,105 & 0,032 & FAC6 \\
0,097 & 0,072 & 0,051 & 0,060 & 0,086 & 0,087 & 0,000 & 0,076 & 0,066 & 0,046 & FAC7 \\
0,092 & 0,084 & 0,079 & 0,058 & 0,092 & 0,113 & 0,089 & 0,000 & 0,096 & 0,155 & FAC8 \\
0,138 & 0,083 & 0,073 & 0,070 & 0,102 & 0,106 & 0,095 & 0,080 & 0,000 & 0,023 & FAC9 \\
0,143 & 0,062 & 0,065 & 0,074 & 0,049 & 0,030 & 0,038 & 0,057 & 0,021 & 0,000 & FAC10
\end{array}
$$

$$
ID = D^2 (I - D)^{-1}. \quad (3)
$$

Then, the result of calculating the indirect-influence matrix can be seen in Indirect Influence-Relation of Success Factor.

ID =

FAC1	FAC2	FAC3	FAC4	FAC5	FAC6	FAC7	FAC8	FAC9	FAC10	
0, 267	0, 211	0, 163	0, 173	0, 221	0, 221	0, 194	0, 159	0, 177	0, 160	FAC1
0, 299	0, 250	0, 187	0, 191	0, 241	0, 242	0, 225	0, 186	0, 196	0, 162	FAC2
0, 179	0, 150	0, 117	0, 120	0, 147	0, 157	0, 145	0, 116	0, 124	0, 107	FAC3
0, 240	0, 192	0, 149	0, 164	0, 206	0, 207	0, 183	0, 153	0, 169	0, 151	FAC4
0, 262	0, 225	0, 166	0, 177	0, 238	0, 234	0, 204	0, 177	0, 187	0, 165	FAC5
0, 275	0, 224	0, 173	0, 179	0, 227	0, 245	0, 209	0, 171	0, 184	0, 168	FAC6
0, 226	0, 189	0, 144	0, 150	0, 191	0, 195	0, 181	0, 142	0, 157	0, 139	FAC7
0, 296	0, 238	0, 181	0, 193	0, 243	0, 242	0, 218	0, 187	0, 193	0, 163	FAC8
0, 263	0, 225	0, 169	0, 177	0, 227	0, 232	0, 208	0, 170	0, 193	0, 167	FAC9
0, 179	0, 158	0, 117	0, 121	0, 160	0, 167	0, 147	0, 120	0, 133	0, 118	FAC10

Fourth step. The fourth step is calculating the total relation matrix with equation (4) (Lin and Lin, 2008). The total relation matrix indicates the threshold value, the total effect (both direct and indirect) given by factor i to other factors and the total effect (both direct and indirect) received by factor j from other factors.

$$T = D(1 - D)^{-1} \tag{4}$$

The result of calculating the total relation matrix can be seen in Total Relation of Success Factor.

T =

FAC1	FAC2	FAC3	FAC4	FAC5	FAC6	FAC7	FAC8	FAC9	FAC10	
0, 267	0, 311	0, 221	0, 227	0, 296	0, 323	0, 302	0, 262	0, 260	0, 213	FAC1
0, 390	0, 250	0, 239	0, 288	0, 355	0, 375	0, 295	0, 245	0, 286	0, 315	FAC2
0, 279	0, 213	0, 117	0, 164	0, 253	0, 214	0, 160	0, 143	0, 175	0, 145	FAC3
0, 329	0, 328	0, 217	0, 164	0, 280	0, 302	0, 261	0, 206	0, 217	0, 191	FAC4
0, 416	0, 318	0, 259	0, 261	0, 238	0, 333	0, 321	0, 221	0, 261	0, 199	FAC5
0, 369	0, 327	0, 234	0, 260	0, 345	0, 245	0, 309	0, 251	0, 289	0, 201	FAC6
0, 324	0, 261	0, 195	0, 210	0, 277	0, 282	0, 181	0, 218	0, 223	0, 185	FAC7
0, 387	0, 322	0, 260	0, 251	0, 335	0, 355	0, 307	0, 187	0, 289	0, 317	FAC8
0, 401	0, 308	0, 241	0, 247	0, 329	0, 338	0, 303	0, 250	0, 193	0, 190	FAC9
0, 323	0, 220	0, 182	0, 195	0, 210	0, 197	0, 185	0, 177	0, 153	0, 118	FAC10

The threshold value for the percentage of milk supply from national production (FAC1) and the threshold value for the number of dairy cattle ownership by each farmer (FAC2) can be obtained by calculating the average of columns FAC1 and FAC2, respectively, in matrix T. The calculated threshold values for FAC1 and FAC2 are 0.349 and 0.286, respectively. Based on this threshold value, factors that influence the percentage of milk supply from national production are the number of dairy cattle ownership by each farmer (FAC2), national milk production (FAC5), total number of adult female cattle (FAC6), amount of milk import (FAC7) and national milk demand (FAC9). These factors have value in column more than the threshold value for the percentage of milk supply from national production (FAC1). Factors that influence the number of dairy cattle ownership by each farmer are percentage of milk supply from national production (FAC1), total number of dairy farmers (FAC4), national milk production (FAC5), total number of adult female cattle (FAC6), number of dairy cattle import (FAC8) and national milk demand (FAC9). These factors have value in column more than the threshold value for the number of dairy cattle ownership by each farmer (FAC2).

Fifth step. The fifth step is finding the total degree to which a specific factor exerted influence on and was influenced by other factors and the degree to which a factor affected and was affected by other factors. In this step, we have to calculate the sum of row (r_i) and the sum of column (c_i) from the total relation matrix and calculate the value of ($r_i + c_i$) and ($r_i - c_i$). Table 2 presents the results of the calculations ($r_i + c_i$) and ($r_i - c_i$). The value of ($r_i + c_i$) or prominence indicated the total degree to which a factor exerted influence on and was influenced by the other factors. The value of ($r_i - c_i$) or relation indicated the difference in the degree to which a factor affected and was affected by the other factors (Figure 3).

According to Table 2, the factors are arranged in terms of the degree of their importance based on their respective ($r + c$) scores. The percentage of milk supply from national production (FAC1) with an ($r + c$) score of 6.67 has the highest degree of importance followed by FAC2, FAC6, FAC5, FAC8, FAC9, FAC7, FAC4, FAC10 and FAC3. Further,

Table 2.
Sum of influences given and received on success factors

Factors	r	c	$r + c$	r-c
Percentage of milk supply from national production (FAC1),	2.682	3.485	6.167	−0.803
The number of dairy cattle ownership by each farmer (FAC2),	3.038	2.858	5.896	0.180
The number of trained dairy farmers (FAC3),	1.863	2.165	4.028	−0.302
The total number of dairy farmers (FAC4)	2.495	2.267	4.762	0.228
The national milk production (FAC5)	2.827	2.918	5.745	−0.091
The total number of adult female dairy cattle (FAC6)	2.830	2.964	5.794	−0.134
The amount of milk import (FAC7)	2.356	2.624	4.980	−0.268
The number of dairy cattle import (FAC8)	3.010	2.160	5.170	0.850
National milk demand (FAC9)	2.800	2.346	5.146	0.454
The natural growth rate of the dairy cattle (FAC10)	1.960	2.074	4.034	−0.114

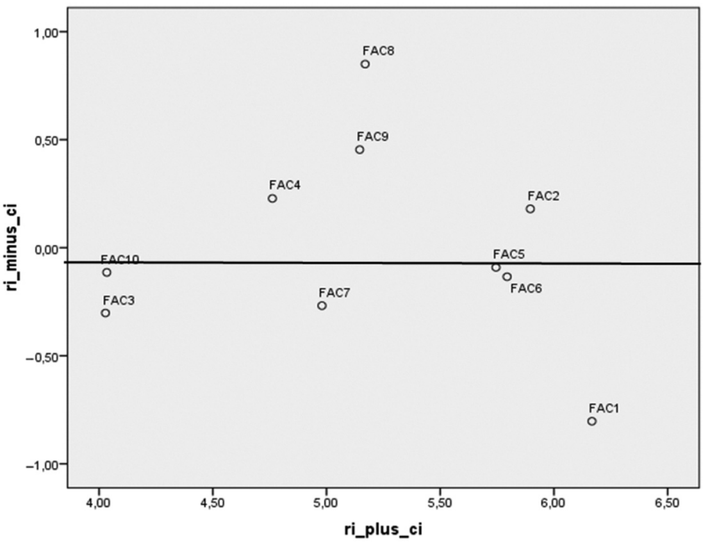


Figure 3.
The cause–effect diagram of success factors of the Indonesian dairy supply chain

after considering the value of their respective $(r-c)$ scores, the number of dairy cattle ownership by each farmer (FAC2), the total number of dairy farmers (FAC4), the number of dairy cattle import (FAC8), and national milk demand (FAC9) are divided into cause group factors. By contrast, the percentage of milk supply from national milk production (FAC1), the number of trained dairy farmers (FAC3), national milk production (FAC5), the total number of adult female dairy cattle (FAC6), the amount of milk import (FAC7) and the natural growth rate of dairy cattle (FAC10) come under the effect group.

As the values of (r) and (c) for individual factors signify the amount of influence given and received on the complete system respectively, the cause group factors are essential because of their direct impact on the overall system (Mangla *et al.*, 2014). Thus, it would be important to address and focus on the cause group factors for increasing the performance of the dairy supply chain. Among all the cause group factors, the number of dairy cattle import (FAC8) had the highest $(r-c)$ score of 0.850, which implies that FAC8 has the most impact on the whole system. However, its $(r+c)$ score (5.170) is comparatively low, which can be justified by the fact that the number of dairy cattle import (FAC8) can have an influence on the other factors but receive comparatively less influence in return. The highest impact of FAC8 on the performance of the Indonesian dairy supply chain is in line with the results of previous research conducted by Susanty *et al.* (2019). Based on the result of the simulation, their research indicated that the policy scenario with the greatest impact for better performance is a policy scenario that incorporates dairy cattle import policy. This condition also indicated that the effective government policy related to dairy cattle import along with clarity of the implementation of this policy plays a role in shaping the Indonesian dairy milk supply chain. The second highest factor in the $(r–c)$ column is the national milk demand, with a score of 0.454. Not different from (FAC8), the $(r+c)$ score (5.146) is comparatively low; this can be justified by the fact that national milk demand (FAC9) can have an influence on the other factors but receive comparatively less influence in return. The total of the number of dairy farmers (FAC4) with an $(r-c)$ score of 0.228 and the number of dairy cattle ownership by each farmer (FAC2) with an $(r-c)$ score of 0.180 hold the third and fourth ranks in signifying their influence on the overall system in increasing the performance of the Indonesian dairy supply chain. In dealing with the issue of low welfare of dairy farmers that causes them to move to other businesses, the amount of ownership of cattle or the herd size is an important factor for increasing the welfare of the farmers through economic efficiency (Herrero *et al.*, 2010; Masuku *et al.*, 2014). As the farmers can increase their welfare, the probability to move to the other businesses will be low, and this condition will influence the stability of milk supply.

Factors in the effect group tend to be easily influenced by other factors. However, these group factors do not have a direct impact on the system but still make a significant contribution (Mangla *et al.*, 2014). Therefore, these factors need to be described to find out their contribution in an overall manner. In all the effect group factors, the percentage of milk supply from national production (FAC1) obtained the least $(r-c)$ score, i.e. −0.803, which implies that this factor receives the maximum impact from all other factors. Additionally, it is among the top factors according to the $(r+c)$ score of 6.167, implying the importance of this factor. The percentage of milk supply from national production is the most important factor for any policy implementation in the dairy supply chain as it helps to achieve the proposed target by the government. The other factors, which follow the sequence of the priority list in the effect group, include the number of trained dairy farmers (FAC3), the amount of dairy milk import (FAC8), the total number of adult female dairy cattle (FAC6), the natural growth rate of the dairy cattle (FAC10) and national milk production (FAC5).

Alt. Policies	Respondent (Round 2)										Respondent (Round 3)									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	Mean	R1	R2	R3	R4	R5	R6	R7	R8	R9	Mean
PLC1	5	5	5	4	4	5	5	4	5	4.67	5	5	5	5	5	5	5	5	5	5.00
PLC2	5	5	3	4	4	5	4	5	4	4.33	4	4	4	4	4	4	4	4	4	4.00
PLC3	5	5	5	4	5	5	5	5	5	4.89	5	5	4	5	5	5	4	5	5	4.78
PLC4	5	4	4	5	5	4	4	5	3	4.33	5	4	5	5	4	5	5	5	5	4.78
PLC5	5	3	5	5	5	4	5	5	5	4.67	5	5	5	4	5	5	4	5	5	4.78
PLC6	5	3	4	4	5	3	3	5	5	4.11	4	5	5	4	5	5	5	5	5	4.78
PLC7	3	4	3	4	4	4	4	3	3	3.56										
PLC8	4	5	3	3	5	4	4	3	3	3.78										
PLC9	5	4	4	4	5	3	4	5	5	4.33	4	4	4	4	4	4	4	4	4	4.00
PLC10	5	4	5	5	5	4	4	5	4	4.56	5	5	5	4	5	5	5	5	5	4.89
PLC11	5	4	5	5	4	5	4	4	5	4.56	5	5	5	5	5	5	5	5	5	5.00
PLC12	5	4	5	5	4	4	4	4	3	4.22	4	4	5	5	5	5	5	5	5	4.78
PLC13	5	5	5	5	5	5	5	4	5	4.89	5	5	5	4	5	5	5	5	4	4.78
PLC14	5	4	5	5	5	4	5	5	4	4.67	4	4	4	5	4	4	4	5	4	4.22
Test statistics	N									9	*N*									9
	Kendall's W^a									0.281	Kendall's W^a									0.543
	Chi-square									32.91	Chi-square									53.761
	df									13	df									11
	Asymp. Sig.									0.002	Asymp. Sig.									0.000

Notes: PLC1: assist in the procurement of imported cattle for farmers; PLC2: standardization of the milk quality produced by dairy cooperative; PLC3: provide the reward system for the farmers (this system can help to increase the passion of the farmers to continuously improve the quality and quantity of milk being produced); PLC4: increase the level of formality of the contract between the farmers and the cooperative, so the farmers and cooperative can get the same understanding about their rights and obligation; PLC5: the industrial milk processing should use a national milk production for their raw material; PLC6: the operational grant (such as a vaccine, cattle fodder) for the farmers to improve the capability of their farms in producing dairy milk with high quality; PLC7: establish communal cages as the joint cultivated by several farmers to achieve the economies of scale and efficiency of the farms business; PLC8: increase the number of dairy farmers by making farms activities as an additional activity for agricultural activities; PLC9: develop and implement structured training for farmers to improve their ability and professionalism in managing their farms; PLC10: improve the partnership system between farmers and dairy cooperative; PLC11: provide financial assistance to the farmers in the form of low-interest financing; PLC12: conduct the structured research for the development of methods milking process which can be applied at the level of small-scale farms at low cost; PLC13: periodic adjustments to the feasibility of milk prices at the dairy farmer and cooperative levels; PLC14: dairy cooperatives and local government provide land that can be used by the farmers for forage feed of their cattle; this policy can improve the income of the farmers as the cost for purchasing the forage feed decrease

Table 3. Result of close-ended questions from second round and third round Delphi method

Policy recommendation based on the Delphi method

The findings obtained from the DEMATEL method were discussed with some experts to find alternative policies that can support the cause group factors (these factors have a direct impact on the overall system). This research used the Delphi method to formulate those policies. The Delphi method was administered for three rounds. The first round was used to generate the proposed policies and the second and third rounds were used to validate the policies generated from the first round. The results for second and third rounds are summarised in Table 3.

When reviewing the data from Rounds 2 and 3, we decided that any policy with an average rating of 4.0 or higher would be regarded as an important alternative policy; otherwise, the alternative policy will be excluded from the list. It can be seen, in Round 2, that alternative policies establish communal cages as the joint cultivated by several farmers

Table 4.
Ranking the alternative policies

Alternative policies	Mean rank based on Kendall’s test	Rank
PLC1	8,61	1
PLC11	8,61	2
PLC10	7,94	3
PLC3	7,28	4
PLC4	7,28	5
PLC5	7,28	6
PLC6	7,28	7
PLC12	7,28	8
PLC13	7,28	9
PLC14	3,94	10
PLC2	2,61	11
PLC9	2,61	12

to achieve the economies of scale and efficiency of the farms’ business (PLC7) and increase the number of dairy farmers by making farm activities an additional activity for agricultural activities (PLC8) have an average value below 3. As a consequence of this condition, the two alternative policies were excluded from the list and not included in the questionnaire given to the experts in the third round. Average Input Direct-Relation of Success Factor presents the result of Kendall’s *W* test for the second round. Since the Kendall’s *W* of this round is 0.281, which is less than 0.5, the Delphi method should be continued to the third round. Kendall’s coefficient of concordance (Kendall’s *W*) represented the level of consensus between the participants (Schmidt, 1997; Habibi *et al.*, 2014); it ranges from 0 to 1, indicating the degree of consensus reached by the panel (the value of Kendall’s *W* more than 0.7 indicated a strong consensus; the value of Kendall’s *W* equalling 0.5 indicated a moderate consensus and the value of Kendall’s *W* less than 0.3 indicated a weak consensus) (Habibi *et al.*, 2014). Then, based on the remaining 12 alternative policies, the third-round questionnaire was designed and distributed to the experts. It can be seen that in Round 3, all alternative policies have an average value above 4. This condition indicated that all the remaining policies were important for improving the performance of the Indonesian dairy supply chain. As Kendall’s *W* of the third round is 0.543, which is more than 0.5, the Delphi method can be stopped. The final alternative policies and their rank according to the response of the experts and Kendall’s test can be seen in Table 4.

The result of applying the Delphi method indicated the top five alternative policies, i.e. the government’s provision of assistance for the procurement of imported cattle, provision of financial assistance to the farmers in the form of low-interest financing, improvement of the partnership system between farmers and dairy cooperatives, provision of the reward system for the farmers (this system can help to increase the passion of the farmers to continuously improve the quality and quantity of milk being produced) and increase of the level of formality of the contract between the farmers and the cooperatives, so that the farmers and cooperatives have the same understanding about their rights and obligations.

Related to the proposed alternative policies, in the past, the government has introduced the alternative policy of massive dairy cattle import through subsidising the dairy cattle import programmes; as a result, domestic milk production increased continuously during the 1980s to the early 1990s (Sudaryanto and Hermawan, 2014). However, imports are not the only way for the government to increase the number of dairy cattle and the amount milk production; another way to increase the number of dairy cattle is through the process of enlarging calves in the country through the Special Efforts (Upsus) for Obligation of Cow Pregnant (SIWAB) programme in 2016. The Siwab program is stated in Permentan No.48/

Permentan/PK.210/10/2016 (Agus and Widi, 2018; Rusdiana and Soeharson, 2017). The government set a target of 4 million head of productive female cattle would be inseminated and reach a minimal 75% pregnancy rate or calving 3 million calves. In this programme, a cow must be pregnant through two mating systems, namely, AI and natural mating. In this programme, the government set a target for the number of productive female cattle to be inseminated and the minimal pregnancy rate or number of calves born. To support the SIWAB programme, improvement of feeding was done by planting grass and legumes and providing water sources. Moreover, to improve animal health, medicines and vaccines were provided. Until 2017, the success of the SIWAB programme, in terms of the calving rate, has not been achieved. Some sources reported by the end of 2017, 92.27% of the AI target was achieved while the calving rate was 54.13% from the set target (Rusdiana and Soeharson, 2017).

Then, related to the alternative policy of financial assistance to the farmers, the government has been promoting the importance of access to finance for smallholders through subsidies and Kredit Usaha Rakyat (KUR) with at least a six-month grace period to upgrade their facilities and boost milk production. The government provides guarantees on behalf of the dairy farmers or debtors who obtain KUR, through credit guarantee institutions such as through PT. Askrindo and Perum Jamkrindo or other credit guarantee institutions. The mechanism for calculating the premium amount (fee) is carried out on the basis of the realisation and the percentage of the premium rate determined in accordance with the portion of the guarantee borne by the government. Another form of financial assistance socialised by the government since 2007 is the Food and Energy Security Credit Program (KKPE). This credit programme was intended for working capital and/or for investment activities. The financial assistance from the government to the dairy farmers cannot be separated from the role of dairy cooperatives.

Related to the third alternative policy, the importance of a stronger partnership or relationship between the farmers and dairy cooperatives has been discussed in many works of literature, including Gupta and Roy (2012), Susanty *et al.* (2017) and Mahida *et al.* (2018). The farmers may have benefited from the good partnership or relationship with dairy cooperative as they may have higher profit and better technical efficiency because the cooperative can provide a cheaper input and resource services. Then, the stronger relationship between dairy farmers and cooperative can increase the level of loyalty of dairy farmers, which, in turn, can affect the performance of cooperative through the stability of quantity and quality of milk delivered by the farmers. Improving the relationship between dairy farmers and cooperative cannot be separated from the clarity and formality of the contract between the two parties as to the cooperative deals with principal-agent problems, which are likely to arise because the objectives of the agent are typically not the same as those of the principal; thus, the agent may not always best represent the interests of the principal.

Conclusion

This research used the DEMATEL method to identify and analyse the most important factor in improving the performance of Indonesia's dairy milk supply chain and the interaction among the success factors. Four factors had higher values of influence over the other factors but received comparatively less influence in return. It can be said that those four factors have a higher direct impact on the overall system compared to six other factors. The four factors are the number of dairy cattle import, national milk demand, the total number of dairy farmers, and the number of dairy cattle ownership or the herd size. Related with our previous research, the number of dairy cattle import scenarios was proven to be able to improve the performance of Indonesia's dairy milk supply chain as seen from the simulation results. The alternative scenario of massive dairy cattle import programmes has a significant impact on boosting the number of dairy cattle ownership and the percentage of milk demand supplied by national milk indicators and on reducing the government trade balance (Susanty *et al.*, 2019). Then, based on findings obtained from the DEMATEL method, the alternative policies that can support the factors with higher direct impact were identified and analysed with the experts through the Delphi method. The result of applying the Delphi method indicated the top five alternative policies, i.e. the government's provision of assistance for the procurement of imported cattle, provision of financial assistance to the farmers, improvement of the partnership system between farmers and dairy cooperatives, provision of the reward system for the farmers, and increase of the level of formality of the contract between the farmers and the cooperatives.

Finally, related to alternative policy that provides system reward for the farmers, rewards or incentives are used to improve dairy farms' performance and are typically paid by processors when a predetermined level of milk quality or another condition is attained. Basically, there are many bases for providing such incentives, for example, incentives for increasing the pregnancy rate, incentives for calf raising, milk quality incentives, feeding management incentives, hoof care incentives and herd health incentives. Incentives include not only payment systems but also services related to the raw material supply, i.e. contracts to provide feed for calves and heifers, farmer training programmes, availability of credit or preferential payment, access to farm management and profitability advice.

The findings of this research have important managerial implications for the government or policymakers. It will assist the government in segmenting the success factors into some meaningful portions to effectively facilitate decision-making on prioritising policy for improvement and taking appropriate steps for the betterment of the dairy milk supply chain in Indonesia. Thus, to be in line with the policies produced by this research to support the success factors that have the higher value in influencing over the other factors, government budgets must be focused on procuring imported dairy cattle, providing assistance and subsidies to the farmers, improving relations between farmers and cooperatives and developing appropriate incentive schemes.

This research offers several significant contributions to both theory and practice. In the theory, a combination of causal relationship diagram of System Dynamic and DEMATEL method as a qualitative and quantitative method in one integrated way through performance dairy supply chain analysis is the most important part of this research. First, this research use causal relationship diagram as a qualitative method to indicate the factors that contributed to the performance of dairy milk supply chain (it does not provide information about the magnitude of influence of the relationships between and among factors) and then, use DEMATEL as a quantitative method to identify and analyse the most important factor. In the practices, this research offers a significant contribution to the domain of policy formulation for the Indonesian dairy milk supply chain. The present research has presented 10 success factors based on the causal relationship diagram, which was validated with the opinions of the experts. The enumerated success factors will assist in improving the performance of the Indonesian dairy supply chain. Then, the structural model offered by this research will deliver the suggestion of how these factors are arranged to improve the performance of the Indonesian dairy supply chain according to their importance and their ranking; whether included in the cause group or the effect group. It is worthy to differentiate the factors according to their importance and position (cause or effect factors) as the common policymakers' targets on few factors by assuming that some factors are more important than the others. The DEMATEL-based proposed model will assist the policymakers in knowing the level and position of different factors to improve the performance of the Indonesian dairy supply chain. Moreover, the Delphi method used in this research will help to make sure that selected alternative policies are a consensus that has been thought and agreed upon by several experts.

Nonetheless, this research is not free from limitations. These limitations set stages for future research. However, it is imperative to note that the possible limitation of the research concerning its application in the Indonesia dairy milk supply chain context does not restrict either its generalizability or its applicability in a wider context. In this case, although the dynamic structure represents the interrelationships of each success factor and the most important influencing success factor which are significant for the performance of the Indonesian dairy supply chain may not be generalized for all dairy milk supply chain, the success factors included in the DEMATEL process were identified by referring to the findings of the literature review such as Okano *et al.* (2014), Dizyee *et al.* (2019), and Bórawski *et al.* (2020) as well as the previous research conducted by Susanty *et al.* (2019), so the finding obtained related to success factors could be generally for other dairy milk supply chains with similar involved actors and characteristics. The interrelationships of each factor and the most important influencing factors could not be generally because it depends on the point of view of the experts. Different experts can have different opinions related to the problem faced by a certain dairy milk supply, which affects the performance of the chain. Future research can apply the success factors proposed by this research to the different dairy milk supply chain. The application can confirm and broaden the validity of the interrelationships of each factor and the most important influencing factors to other dairy milk supply chain. This research used only nine experts for formulating alternative policies. Future research may repeat this method using multiple experts to justify the validity of the research. Moreover, this research has explored only the 21 success factors for increasing the performance of the Indonesian dairy supply chain from a limited causal relationship diagram (only from a supply-side and the number of dairy cattle); hence, conclusions may not be sufficient to explain the total behavior of the dairy supply chain. Future studies should evaluate several success factors from the causal relationship diagram in the broader dairy milk supply chain, not only on the supply side and the number of dairy cattle.

References

Agus, A. and Widi, T.S.M. (2018), "Current situation and future prospects for beef cattle production in Indonesia – a review", *Asian-Australasian Journal of Animal Sciences*, Vol. 31 No. 7, pp. 976-983.

Alias, E.S., Mukhtar, M. and Jenal, R. (2019), "Instrument development for measuring the acceptance of UC&C: a content validity study", *International Journal of Advanced Computer Science and Applications*, Vol. 10 No. 4, pp. 187-193.

Beber, C.L., Carpio, A.F.R., Almadani, M.I. and Theuvsen, L. (2019), "Dairy supply chain in Southern Brazil: barriers to competitiveness", *International Food and Agribusiness Management Review*, Vol. 22 No. 5, pp. 651-673.

Bórawski, P., Pawlewicz, A., Parzonko, A., Harper, J.K. and Holden, L. (2020), "Factors shaping cow's milk production in the EU", *Sustainability*, Vol. 12 No. 1, pp. 1-15.

Chari, F. and Ngcamu, B.S. (2017), "An assessment of the impact of disaster risks on dairy supply chain performance in Zimbabwe", *Cogent Engineering*, Vol. 4 No. 1, pp. 1-14.

Chien, K.F., Wu, Z.H. and Huang, S.C. (2014), "Identifying and assessing critical risk factors for BIM projects: empirical study", *Automation in Construction*, Vol. 45, pp. 1-15.

Daud, A.R., Putro, U.S. and Basri, M.H. (2015), "Risks in milk supply chain; a preliminary analysis on smallholder dairy production", *Livestock Research for Rural Development*, Vol. 27 No. 7, pp. 1-14.

DeVon, H.A., Block, M.E., Moyle-Wright, P., Ernst, D.M., Hayden, S.J., Lazzara, D.J., Savoy, S.M. and Kostas-Polston, E. (2007), "A psychometric toolbox for testing validity and reliability", *Journal of Nursing Scholarship*, Vol. 39 No. 2, pp. 155-164.

Dizyee, K., Baker, D. and Omore, A. (2019), "Upgrading the smallholder dairy value chain: a system dynamics ex-ante impact assessment in Tanzania's Kilosa district", *Journal of Dairy Research*, Vol. 86 No. 4, pp. 440-449.

Dries, L., Gorton, M., Urutyan, V. and White, J. (2014), "Supply chain relationships, supplier support programmes and stimulating investment: evidence from the Armenian dairy sector, Supply Chain Management", *Supply Chain Management: An International Journal*, Vol. 19 No. 1, pp. 98-107.

Duteurtre, G., Sembada, P. and Nguyen, M.H. (2018), "Past experiences and future challenges to design sustainable policies and strategies", Report of the Workshop 'Foresight scenarios for the dairy sector in Indonesia', 4 December.

Federico, G., Magdalena, M. and Nicholas, J. (2011), "The challenges of a consolidated supply chain to British dairy farmers", *Socialiniai Tyrimai/Social Research*, Vol. 2 No. 23, pp. 90-99.

Gabus, A. and Fontela, E. (1972), *World Problems, an Invitation to Further thought within the Framework of DEMATEL*, Battelle Geneva Research Centre, Geneva.

Gabus, A. and Fontela, E. (1973), *Perceptions of the World Problematique: Communication Procedure, Communicating with those Bearing Collective Responsibility (DEMATEL Report no. 1)*, Battelle Geneva Research Centre, Geneva.

Garvey, J., Sirr, G., O'Shea, D. and O'Brien, F. (2018), "Risk and planning in agriculture: how planning on dairy farms in Ireland is affected by farmers' regulatory focus", *Risk Analysis*, Vol. 39 No. 7, pp. 1491-1502.

Ghosh, A., Sindhu, S., Panghal, A. and Bhayana, S. (2014), "Modelling the enablers for risk management in milk processing industry", *International Journal of Management and International Business Studies*, Vol. 4 No. 1, pp. 9-16.

Glover, J.L., Champion, D., Daniels, K.J. and Dainty, A.J.D. (2014), "An institutional theory perspective on sustainable practices across the dairy supply chain", *International Journal of Production Economics*, Vol. 152, pp. 102-111.

Gupta, K. and Roy, D. (2012), "Gains from coordination in milkfed dairy in Punjab", *Journal of Agribusiness in Developing and Emerging Economies*, Vol. 2 No. 2, pp. 92-114.

Habibi, A., Sarafrazi, A. and Izadyar, S. (2014), "Delphi technique theoretical framework in qualitative research", *The International Journal of Engineering and Science*, Vol. 3 No. 4, pp. 8-13.

Herrero, M., Nganga, S.K., Kungu, J. and de Ridder, N. (2010), "Profit efficiency among Kenyan smallholder milkproducers: a case study of Meru-South District, Kenya", *African Journal of Agricultural Research*, Vol. 5 No. 4, pp. 332-337.

Issar, G., Cowan, R.T. and Wegener, M.K. (2003), "Success strategies being implemented in fresh milk supply chains", *International Farm Management Congress*, 10-15 August.

Knight, S., Aggarwal, R., Agostini, A., Loundou, A., Berdah, S. and Crochet, P. (2018), "Development of an objective assessment tool for total laparoscopic hysterectomy: a Delphi method among experts and evaluation on a virtual reality simulator", *PloS One*, Vol. 13 No. 1, pp. 1-14.

Kong, J. (2011), "Development and validation of the multicultural school-based consultation competency scale", Doctoral Dissertation, The City University of New York Institute of Educational Sciences, New York, NY.

Kumar, R. (2014), "Performance measurement in dairy supply chain management", *Paripex – Indian Journal of Research*, Vol. 3 No. 5, pp. 100-101.

Kumar, R. and Mohan, A. (2014), "Antecedent of dairy supply chain management practices: a conceptual framework", *Journal of Supply Chain Management Systems*, Vol. 3 No. 1, pp. 48-67.

Kumar, S. and Nigmatullin, A. (2011), "A system dynamics analysis of food supply chains – case study with non-perishable products", *Simulation Modelling Practice and Theory*, Vol. 19 No. 10, pp. 2151-2168.

Kumar, A., Staal, S.J. and Singh, D.K. (2011), "Smallholder dairy farmers' access to modern milk marketing chains in India", *Agricultural Economics Research Review*, Vol. 24, pp. 243-254.

Lee, H.S., Tzeng, G.H., Yeih, W., Wang, Y.J. and Yang, S.C. (2013), "Revised DEMATEL: resolving the infeasibility of DEMATEL", *Applied Mathematical Modelling*, Vol. 37 No. 10-11, pp. 6746-6757.

Lemma, H. (2015), "Measuring supply chain coordination in milk and dairy industries: a confirmatory factor model", *International Journal of Economics and Management Science*, Vol. 4 No. 4, pp. 1-7.

Lin, K.M. and Lin, C.W. (2008), "Cognition map of experiential marketing strategy for hot spring hotels in Taiwan using the DEMATEL method", *Fourth International Conference on Natural Computation*, IEEE, Vol. 1, October, pp. 438-442.

Liu, X. and Arthanari, T. (2016), "A system dynamics model for managing corruption risks in dairy supply chains", *The 34th International Conference of the System Dynamics Society*, 17-21 July, pp. 1-17.

Lynn, M.R. (1986), "Determination and quantification of content validity", *Nursing Research*, Vol. 35 No. 6, pp. 382-385.

Mahida, D., Sendhil, R., Sirohi, S., Chandel, B.S., Ponnusamy, K. and Sankhala, G. (2018), "Potential impact of dairy cooperatives on sustainable milk production: evidence from Gujarat, India", *Indian Journal of Economics and Development*, Vol. 14 No. 1a, pp. 402-409.

Mangla, S., Kumar, P. and Barua, M.K. (2014), "An evaluation of attribute for improving the green supply chain performance via DEMATEL method", *International Journal of Mechanical Engineering and Robotics*, Vol. 1 No. 1, pp. 30-35.

Masuku, B.B., Masuku, M.B. and Belete, A. (2014), "Economic efficiency of smallholder dairy farmers in Swaziland: an application of the profit function", *Journal of Agricultural Studies*, Vol. 2 No. 2, pp. 132-146.

Mehregan, M., Razavi, S.M. and Akhavan Anvari, M.R. (2012), "Identification and evaluation of strategic decisions in gas industry using DEMATEL Method", *Iranian Journal of Management Studies*, Vol. 5 No. 5, pp. 49-65.

Mishra, P.K. and Shekhar, B.R. (2011), "Impact of risks and uncertainties on supply chain: a dairy industry perspective", *Journal of Management Research*, Vol. 3 No. 2, pp. 1-18.

Mor, R.S., Singh, S., Bhardwaj, A. and Bharti, S. (2017), "Exploring the causes of low-productivity in Dairy industry using AHP", *Jurnal Teknik Industri*, Vol. 19 No. 2, pp. 83-92.

Mor, R.S., Bhardwaj, A. and Singh, S. (2018), "Benchmarking the interactions among performance indicators in dairy supply chain: an ISM approach", *Benchmarking: An International Journal*, Vol. 25 No. 9, pp. 3858-3881.

Moran, J. and Morey, P. (2015), "Strategies to increase the domestic production of raw milk in Indonesia and other South East Asian countries", *International Seminar on Tropical Animal Production*, 12-14 September, pp. 1-11.

Morey, P. (2011), "Dairy industry development in Indonesia", available at: www1.ifc.org/wps/wcm/connect/93f48d00470e3bf883ffd7b2572104ea/Dairy+Industry+Development-2011.pdf

Nasir, T., Quaddus, M. and Shamsuddoha, M. (2014), "Dairy supply chain risk management in Bangladesh: field studies of factors and variables", *Jurnal Teknik Industri*, Vol. 16 No. 2, pp. 127-138.

Ning, C., Zhiming, Z., K., Man, T. and Keng, P.N. (2008), "How are supply chains coordinated?", *Journal of Fashion Marketing and Management: An International Journal*, Vol. 12, pp. 384-397.

Okano, M.T., Vendrametto, O. and dos Santos, O.S. (2014), "How to improve dairy production in Brazil through indicators for the economic development of milk chain", *Modern Economy*, Vol. 5 No. 6, pp. 663-669.

Pathusi, S. and Kume, V. (2014), "The Development of clusters as a way to increase competitiveness of business (cased of milk processing indstry in Tirana)", *European Scientific Journal*, Vo. 10 No. 13, pp. 98-116.

Pinior, B., Belaya, V., Petersen, B. and Selhorst, T. (2011), "Structures and relationships in supply chains and networks: conceptual issues and application in German dairy sector", *International Conference on Economics and Management of Networks*, Cyprus, 1-3 December, pp. 1-21.

Prakash, G. and Pant, R.R. (2013), "Performance measurement of a dairy supply chain: a balance scorecard perspective", *International Conference on Industrial Engineering and Engineering Management*, 10-13 December, pp. 196-200.

Prakash, S., Soni, G., Rathore, A.P.S. and Singh, S. (2017), "Risk analysis and mitigation for perishable food supply chain: a case of dairy industry", *Benchmarking: An International Journal*, Vol. 24 No. 1, pp. 2-23.

Robinson, A. (2009), "Driving efficiencies in the cold supply chains", *Food Logistics*, Vol. 1, pp. 10-14.

Rusdiana, S. and Soeharson, S. (2017), "UPSUS SIWAB program for increasing beef cattle population and economical value of livestock enterprise", *Forum Penelitian Agro Ekonomi*, Vol. 35 No. 2, pp. 125-137.

Schmidt, R.C. (1997), "Managing Delphi surveys using nonparametric statistical techniques", *Decision Sciences*, Vol. 28 No. 3, pp. 763-774.

Shepherd, T. and Flanders, A. (2008), "Do shifting milk-production patterns weaken the dairy supply chain? The case for the Southeastern US", *Journal of Food Distribution Research*, Vol. 39 No. 1, pp. 130-137.

Shukla, M. and Jharkharia, S. (2013), "Agri-fresh produce supply chain management: a state-of-the-art literature review", *International Journal of Operations and Production Management*, Vol. 33 No. 2, pp. 114-158.

Si, S.L., You, X.Y., Liu, H.C. and Zhang, P. (2018), "DEMATEL technique: a systematic review of the state-of-the-art literature on methodologies and applications", *Mathematical Problems in Engineering*, Vol. 1, pp. 1-33. Article ID 3696457.

Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E. and Shankar, R. (2008), *Designing and Managing the Supply Chain*, Tata McGraw Hill, New Delhi.

Simonson, S. (2009), "Transforming the fresh food supply-chain", *Food Logisti*, Vol. 116, pp. 14-15.

Sirajuddin, S.N., Malaka, R. and Kasirang, A. (2017), "Factors cause reduction of members of fresh milk production cooperative dairy cattle breeder", *American-Eurasian Journal of Sustainable Agriculture*, Vol. 11 No. 2, pp. 1-7.

Skinner, R., Nelson, R.R., Chin, W.W. and Land, L. (2015), "The Delphi method research strategy in studies of information systems", *Communication Association for Information System*, Vol. 37 No. 2, pp. 1-32.

Strickland, J., Strickland, A., Wang, P., Zimmerly, L. and Moulton, S. (2013), "Online course development using the ADDIE instruction design model: the need to establish validity", *Society for Information Technology and Teacher Education International Conference*, pp. 2651-2658.

Sudaryanto, B. and Hermawan, A. (2014), "Prospek pengembangan sapi perah di Indonesia", *Reformasi Kebijakan Menuju Transformasi Pembangunan Pertanian*, AARD Press, Indonesian Agency of Agricultural Research And Development, Jakarta.

Susanty, A., Bakhtiar, A., Jie, F. and Muthi, M. (2017), "The empirical model of trust, loyalty, and business performance of the dairy milk supply chain: A comparative study", *British Food Journal*, Vol. 119 No. 12, pp. 2765-2787.

Susanty, A., Bakhtiar, A., Puspitasari, N.B. and Mustika, D. (2018), "Performance analysis and strategic planning of dairy supply chain in Indonesia", *International Journal of Productivity and Performance Management*, Vol. 67 No. 9, pp. 1435-1462.

Susanty, A., Bakhtiar, A., Puspitasari, N.B., Susanto, N. and Handjoyo, D.K.S. (2019), "The performance of dairy supply chain in Indonesia: a system dynamics approach", *International Journal of Productivity and Performance Management*, Vol. 68 No. 6, pp. 1141-1163.

Teng, J.Y. (2002), *Project Evaluation: Methods and Applications*, National Taiwan Ocean University, Keelung.

Tilakasiri, K.K. (2015), "Development of new frameworks, standards and principles via Delphi data collection method", *International Journal of Scientific Research*, Vol. 4 No. 9, pp. 1189-1194.

Umar, I.N. and Su-Lyn, Y. (2011), "Instructional design practitioners in Malaysia: skills and issues", *World Academy of Science, Engineering and Technology*, pp. 1413-1417.

Utomo, D. Onggo, B.S.S. and Eldridge, S. (2018), "Modelling dairy supply chain in west java using agent-based simulation", Management Science Working Paper 2018:5, pp. 1-17.

Wright, T. and Meylinah, S. (2014), "Indonesia dairy and products annual report 2014", GAIN Report, No. ID 1438, USDA Foreign Agricultural Service, Jakarta.

Ziad, K.T., Hayat, U. and Bacha, M.S. (2019), "An economic assessment of problems associated with Small-Scale Farmers in the Dairy Sector of Pakistan (a case study of Punjab Province)," *Sarhad Journal of Agriculture*, Vol. 35 No. 1, pp. 194-207.

Zubair, M. and Mufti, N.A. (2015), "Identification and assessment of supply chain risks associated with dairy products sector", *Journal of Basic and Applied Sciences*, Vol. 11, pp. 167-175.

Further reading

Alchian, A.A. and Demsetz, H. (1972), "Production, information costs, and economic organization", *American Economic Review*, Vol. 62 No. 5, pp. 777-795.

Mor, R.S., Singh, S., Bhardwaj, A. and Singh, L.P. (2015), "Technological implications of supply chain practices in agri-food sector: a review", *International Journal of Supply and Operations Management*, Vol. 2 No. 2, pp. 720-747.

Moran, J. (2005), *Business Management for Tropical Dairy Farmers*, CSIRO Publishing, Clayton.

Royer, J.S. (1999), "Cooperative organizational strategies: a neo-institutional digest", *Journal of Cooperatives*, Vol. 14, pp. 44-46.

Stup, R.E., Hyde, J. and Holden, L.A. (2006), "Relationships between selected human resource management practices and dairy farm performance", *Journal of Dairy Science*, Vol. 89 No. 3, pp. 1116-1120.

Sykuta, M.E. and Chaddad, F.R. (1999), "Putting theories of the firm in their place: a supplemental digest of the new institutional economics", *Journal of Cooperatives*, Vol. 14 No. 9, pp. 68-76.

Tsai, S.B., Chien, M.F., Xue, Y., Li, L., Jiang, X., Chen, Q. and Wang, L. (2015), "Using the fuzzy DEMATEL to determine environmental performance: a case of printed circuit board industry in Taiwan", *PloS One*, Vol. 10 No. 6, pp. 1-14.

Van Berkum, S. (2009), "Dairy chain competitiveness in EU's new member states, candidate and potential candidate countries", *German Journal of Agricultural Economics*, Vol. 58 No. 7, pp. 314-323.

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