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Minimizing losses in milk supply chain with sustainability: An example from an emerging economy

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ABSTRACT

Food loss in supply chain is a growing problem due to its environmental, social and economic impacts. Especially in emerging economies losses mostly occur in the first stages of the supply chain including agricultural production and postharvest storage. As an emerging economy, Turkey, also suffers from the food losses in the supply chain. In this study, focus is on raw milk losses in the supply chain since livestock and dairy sectors are one of the most important sectors in Turkey's economy. Aim of this study is firstly, to investigate root causes of raw milk losses in the supply chain and to predict potential raw milk losses. Secondly, presenting a sustainable solution according to the results of the prediction and finally achieving environmental, social and economic benefits for sustainable raw milk supply chain. Grey Method is used to predict potential losses between 2017–2019 and at the end of the study, triple bottom line based sustainable collection center model is suggested for policymakers.

1. Introduction

Food losses and wastes among the supply chain is a globally growing problem and has severe affects against supply chain sustainability. Therefore, it gains attention of both researchers, governments and organizations due to its environmental impacts including inefficient resource utilization, moral dilemmas due to starvation of millions of people around the world and greenhouse gases provided by disposal of food losses and waste (Mena et al., 2011). Moreover, food losses/wastes have direct economic impact on both producers and consumers (FAO, 2011). Hence, it is essential to predict and prevent food losses and wastes in supply chain to avoid potential risks and to gain sustainability advantages by considering environmental, social, and economic dimensions.

Terms of *food loss* and *food waste* are used in different levels of supply chain for description. While food loss occurs due to malfunctioning of the production and supply system or failure in management (e.g. poor storage and packaging, inefficient marketing, improper handling and transportation); food waste is used to define removal of the food from supply chain while it is still edible (Rezaei and Liu, 2017).

Reasons and impacts of food losses and wastes vary according to the product type. Moreover, losses and wastes in the supply chain alters according to the economic level of the country. Parfitt et al. (2010) summarized the relationship between stage of economic development

of the country and features of post-harvest infrastructure of the supply chain. According to their study, low-income countries usually have traditional systems where simple technologies are used and there is a poor integration between stakeholders in their supply chain.

In order to make a deeper analysis and to provide suggestions for sustainable supply chains, it is essential to focus on losses in food supply chain by product groups and supply chain stages. In this study, raw milk losses in milk supply chain are taken into consideration, since the implementation is conducted in one of an emerging economy, Turkey. Livestock and dairy industries are one of the most important income sources in Turkey, therefore, losses and wastes in supply chain for these sectors have significant impacts on Turkey's economy. On the other hand, milk sector is highly complicated in Turkey. There is an unbalanced condition between demand and supply, and it is affected by other sectors easily. Current actions are far away from sustainable concerns and just concentrated on increasing supply without taking losses into consideration. Thus, there is an unknown and chaotic nature present in the milk supply chain in Turkey. Therefore, this nature of the milk supply chain in Turkey causes environmental, social, and economic impacts and it is essential to investigate causes of losses and to propose models to eliminate them in order to gain sustainable advantages. Hence, the novelty of the study is to focus on, firstly predicting and secondly preventing losses within the milk supply chain of an emerging economy by proposing a model based on sustainability.

From this point of view, the objectives of this study are:

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- Firstly, to understand root causes of milk loss in supply chain and to predict milk losses by using Grey Prediction Method,
- Secondly, to propose a collection center model for managers and policymakers to have more sustainable raw milk supply chain.
- Finally, to achieve environmental, social and economic benefits in raw milk supply chain in Turkey.

After the introduction part, this paper has been divided into 6 parts. The first part deals with the literature review related to sustainable supply chain management, sustainable food supply chain, milk supply chain and milk losses/wastes in supply chain. The second part examines the Turkey's condition in terms of milk losses/wastes and present the motivation behind this study in detail. After that, explanations of the methodology, implementation and suggestions for managerial implications are given respectively.

2. Literature review

Literature review part in this study is divided in to two sections. A brief review related to sustainable supply chains is presented. After that sustainable food supply chains and milk supply chains are given.

2.1. Sustainable supply chain management

Global warming and climate change have become a phenomenon and affects the actions of people and their purchasing behavior. Exhaustion of natural resources and environmental pollution are problems for human. If global sustainability regulations are not considered, life sources will be badly affected (Higgins, 2013). Sustainability refers to the use of resources to meet needs (Linton et al., 2007). According to Elkington (1997), supply chain sustainability involves not only the management of environmental impacts but also social and economic impacts, and this managerial view was introduced as “triple bottom line” (TBL) approach in sustainability. Similarly, according to the OECD (2008), sustainability is also related to the realization or fulfillment of human life quality by emphasizing environmental, social and economic performance, in other words TBL dimensions.

As one of the TBL dimension, economic sustainability covers production stages, financial conditions, market share, and revenues. In addition, social sustainability includes both internal and external parties that promote independence in supply chains, quality of life factors including, health and safety, educational opportunities, and employment rates. Environmental sustainability aims removing and decrease of waste, pollution, energy use, emissions, consumption of hazardous materials (Ince and Ozkan, 2015). Moreover, economically, sustainable development in emerging economies depends on economic refinement, where, to achieve a sustainable supply chain, the needs of the public must be considered and the environment protected (Kusi-Sarpong and Sarkis, 2017).

In this study, since the focused area is milk supply chain in terms of milk losses and sustainability, it is essential to give information about the food supply chain first. According to Green (2010), food supply chain is a crucial sector for the world because of food safety. Sustainability should be one of the core aim of the food producers in the globalized world (Green, 2010). Especially, transport is one of the most important parts of the supply chain in the food and beverage industry, also in products that need to be cooled (Food Logistics, 2017).

2.2. Sustainable food supply chain

Food supply chain starts with production and ends with consumption of the food. Food supply process is significant in the supply chain. For instance, the protection of food, and the deterioration that can be experienced during transportation from the rural area to the urban area are some of the important factors. Moreover, losses and the ability to provide a variety of nutritional supplements to the people throughout

the year are also significant points in food supply chain (European Commission, 2014). In order to be sustainable, food safety, providing information of a food product, improving diversity due to rural or urban area, taking care of a safe, and hygienic working environment, especially whole TBL needs should be considered in food supply chain (Smith, 2008).

There are various studies that focus on sustainable food supply chains. For instance, Raak et al. (2017) conducted expert interviews with 13 German food processing companies in their study to measure food waste. Moreover, Bergendahl et al. (2018) analyzed the trans disciplinary approach to improve FEW (Food-Energy-Water) Nexus projects.

In 2017, Sgarbossa and Russo, 2017 derived Closed-Loop Supply Chain (CLSC) models which is a new sustainable model using and recovering waste for food sector, and they focused on the wastes emerged and reused in the food sector. In 2018, Heard et al., 2018 proposed the sustainability implication which is related with connected and autonomous vehicles for food sector. Haass et al. (2015) developed an algorithm which includes distribution network to analyze reducing of the food waste and the carbon emissions based on containers which assumed as “intelligent”.

Additionally, Bravo et al. (2017) analyzed the food supply chain sustainability in two steps as; examining sustainability practices based on collaboration, and analyzing sustainability performance at different supply chain stages in Italy. In 2017, Becker and Ellis, 2017 analyzed the role of sustainability for agri-food supply chain based on triple bottom line which includes environmental, economic, and social impacts.

This study focuses on milk supply chain and milk losses for sustainable practices. In the following section, details of milk supply chain and information about milk losses in supply chain are given.

2.2.1. Milk supply chain and milk loss

Milk and dairy products are the most important food group for human dietary and milk has different types in terms of the level of processing. These are; raw milk, standardized whole milk, non-standardized whole milk, semi-skimmed milk and skimmed milk. In this study, focus is on raw milk, which refers to the milk that has not been heated above 40 °C and it is the subject of the collection phase from the farmers in the milk supply chain (SafeFood, 2008).

Milk supply chain is seen as relatively simple when it is compared to meat and bread supply chain and includes three main stakeholders: dairy farming, processing and packaging, and retail (Mylan et al., 2015). While processors can be categorized as large multinationals, small processors and on-farm processors; retailers or wholesalers include supermarkets, independent shops, restaurants and other food outlets (Glover et al., 2014).

More detailed raw milk supply chain is summarized from the report of National Milk Council (2016) in Fig. 1. Raw milk supply chain begins with breeding which includes veterinary expenses and feeding. Breeders are usually the small farmers that distribute their goods to milk producers. In this part milk is defined as the *raw milk*. Depends on the purpose and the size of milk chain, raw milk may be sent to another collector or directly to producer. Service organizations including patisserie and restaurants also buy raw milk for their products or to sale directly. In the milk processing plants, milk is tested before pasteurization and dairy products, such as cheese and yoghurt, are produced as outputs (Prata, 2016). Milk supply chain ends with the distribution of the products in internal markets or foreign markets depending on the organization.

Milk supply chain may have many environmental impacts, especially in emerging economies, where sustainability of the supply chain is not a priority. With a general green supply chain management view, these environmental impacts can be summarized as vehicle utilization, number of trips, total traveled distance, energy utilization, average handling factor, average length of haul, empty running of vehicles, type

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