IMPROVING THE PERFORMANCE OF THE FORMAL MILK SUPPLY CHAIN USING A LIFE CYCLE APPROACH

B.M.N.W.K. BANDARA

(148476M)

M.Eng. Research Project

MEng/PG Diploma in Manufacturing Systems Engineering
Department of Mechanical Engineering
University of Moratuwa

Sri Lanka

April 2019

IMPROVING THE PERFORMANCE OF THE FORMAL MILK SUPPLY CHAIN USING A LIFE CYCLE APPROACH

B.M.N.W.K. BANDARA

(148476M)

M.Eng. Research Project

Thesis / Dissertation submitted in partial fulfillment of the requirements for the degree Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

April 2019

DECLARATION

This report contains no material which has been accepted for the award of any other degree or diploma in any university or equivalent institution in Sri Lanka or abroad, and that to the best of my knowledge and belief, contains no material previously published or written by any other person, except where due reference is made in the text of this report.

I carried out the work described in this report under the supervision of Dr. Himan K.G. Punchihewa.

Signature : Date : 08 Apr 2019

Name of Student : B.M.N.W.K. Bandara

Registration No : 148476 M

The above candidate has carried out research for the Masters Thesis under my supervision.

Signature : Date : 08 Apr 2019

Name of Supervisor : Dr. Himan K.G. Punchihewa

Abstract

In Sri Lanka, approximately 54.2 percent of the entire milk available for 2015 came from the formal milk supply chain and the rest was directed informally and consumed at home. The performance of supply chains in sustainability, is always on focus of continued trade growth. Therefore, new strategies and methods are required for risk-oriented and opportunity-oriented supply chain management. The methodology for the Life Cycle Assessment (LCA) can be described as a scientific technique to systematically evaluate the resource use of the product or service during the life cycle. Because of the high degree of intensity of energy affecting the overall performance of the dairy industry, the life cycle impacts linked with energy consumption in the formal milk supply chain is a particular concern.

The aim of this study was thus to increase the performance of the formal milk supply chain by employing a life - cycle approach to examine the effects of energy use in the dairy sector in Sri Lanka and to suggest a framework for evaluating the resulting impact of energy use on the environment. Accordingly, the definite objectives are to examine the use of energy in Sri Lanka's formal milk supply chain, to measure the environmental impacts during the recognized stages of the supply chain, to identify the most critical processes and to explore the resulting impacts of various alternative energy supply situations on the performance of the formal milk supply chain.

The study on the key stages of Sri Lanka's formal milk supply chain directed to the development of a methodology for assessing the impact of energy consumption on the environment during the life cycle. A case study was then carried out at a large-scale dairy manufacturer in Sri Lanka in which a life cycle assessment which was based on the supply chain and energy consumption was carried out. Finally, an impact assessment was done on potential performance variations in various energy supply scenarios. The impact evaluation of the life cycle was carried out by means of the Midpoint (H) method of ReCiPe (Ver 1.11, Dec 2014) in openLCA (version 1.7.0) with the ELCD database (version 3.2, Oct 2015). The results of the research were taken into account to determine the intensity of effects on the environment at the main stages of the supply chain process and to determine the possibility to mitigate negative impacts on the environment.

Finally, it was found that the dairy factory operation phase generally has the highest impact on the environment (64.0 %). Raw milk transportation phase also plays an important role being the second highest (26.3%). By comparing the different alternative energy supply scenarios, solar photovoltaic electricity generation can provide the highest environmental benefits. It was verified with the case study that the dairy sector can reduce the overall impacts approximately by 30% by replacing furnace oil with biomass for thermal energy supply. The use of solar power in milk-producing facilities and milk chilling centers to replace conventional power sources can, however, further reduce the total impact by up to 60 percent. In the long run, substituting conventional energy sources based on fossil fuel with local renewable (green) energy sources will also bring financial advantages to the country, whilst ensuring energy security and independence.

Key words: Life cycle assessment, Formal milk supply chain, Alternative energy, Environmental impact reduction

Acknowledgements

Writing this thesis was one of the most important academic challenges I've ever had to face. This study would not have been completed without the support, patience, and guidance of the following professionals. I owe them my heartfelt gratitude.

First of all, I would be extremely grateful to **Dr. Himan K.G. Punchihewa,** Senior Lecturer of the Department of Mechanical Engineering, University of Moratuwa, Who, despite his many other academic and professional engagements, committed to the role as my research supervisor, was a strength for me. I was inspired and motivated by his wisdom, knowledge, and commitment to the uppermost standards.

Also, I wish to express my appreciation to **Prof. Ruwan Gopura**, Head of the Department of Mechanical Engineering, University of Moratuwa who coordinated all these types of studies of our batch encouraging students and helping students to choose right supervisors for their studies, and facilitating.

I must be grateful to **Mr. Parackrama Weerasekara**, Operations Manager of Shaw Wallace Ceylon Ltd. for directing me to contact resource personal and providing guidance during this study.

I would like to express my gratitude to the Milk Procurement Manager of Richlife Dairies Ltd., **Mr. Mangala Kothalawala** for sharing his decades of experience in Milk Procurement & Milk Supply Chain Management in Sri Lanka with most of the top-class players in Sri Lankan dairy industry.

Also, I must be very grateful to **all the staff members of the Engineering Department, Milk Chilling Centers and Transport Department** of Richlife Dairies Ltd. for helping me in data collection and preparing the summary reports.

Finally, I would like to thank my wife **Dr. Bimalka Perera** for her unstinted support, motivation, love and patience.

Content