



UNIVERSITI PUTRA MALAYSIA

***PERFORMANCE OF A STATE FARMERS' ORGANIZATION ON
BROILER SUPPLY CHAIN BASED ON ENVIRONMENTAL LIFE CYCLE
COSTING IN JOHOR, MALAYSIA***

NUR SYAHIRAH BINTI SAMSUDDIN

FPAS 2018 28



**PERFORMANCE OF A STATE FARMERS' ORGANIZATION ON
BROILER SUPPLY CHAIN BASED ON ENVIRONMENTAL LIFE CYCLE
COSTING IN JOHOR, MALAYSIA**

By

NUR SYAHIRAH BINTI SAMSUDDIN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of the Requirements for the Degree of Master of Science**

March 2018

COPYRIGHT

All material contained within the thesis, including without limitation text, logos, icons, photographs, and all other artwork, is copyright material of Universiti Putra Malaysia unless otherwise stated. Use may be made of any material contained within the thesis for non-commercial purposes from the copyright holder. Commercial use of material may only be made with the express, prior, written permission of Universiti Putra Malaysia.

Copyright © Universiti Putra Malaysia



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

**PERFORMANCE OF A STATE FARMERS' ORGANIZATION ON
BROILER SUPPLY CHAIN BASED ON ENVIRONMENTAL LIFE CYCLE
COSTING IN JOHOR, MALAYSIA**

By

NUR SYAHIRAH BINTI SAMSUDDIN

March 2018

Chairman : Amir Hamzah Bin Sharaai, PhD
Faculty : Environmental Studies

Malaysia currently had achieved full self-sufficiency level in poultry industry. However, the increase in demand for poultry meat due to boost in population and demand for nutritional foods had provided greater pressure towards poultry industry efficiency. Hence, the poultry production sector had been expanded and enlarged to cope with the unexpected demand by Malaysian for poultry products. This situation triggers the existence of integrated system called broiler chicken meat supply chain. Therefore, this study aims to investigate the performance of broiler chicken meat supply chain with the inclusions of environmental cost for sustainable production and environment. The methods employed in this study are based on ELCC general framework which consisted of three stages: 1) goal and scope definition, 2) information gathering 3) identification of significant hotspot. However, the sensitivity analysis that follows attempt to evaluate changes in key variables. The primary data collected through face to face interview consisted of 1 breeder, 30 producers and 1 processor in Johor. The cost structure generated for operational expenditure show that the feed cost had been the major expenditure in breeder and contract farm levels. Meanwhile, for the processing plant, farm gate chicken had become the major operational expense incurred. The environmental cost for the ecosystem was the significant environmental cost hotspot and had been traced throughout the three stages of broiler chicken meat production. After the inclusion of environmental cost in the base line financial model, the performance evaluation results show that a small decline in NPV and IRR value occurred. However, the NPV and IRR value for those three stages are positive, even though the environmental cost was included in the cost of production. Next, the sensitivity analysis was conducted and the results showed that when different scenarios of environmental cost had been included at 5%, 10% and 15%, the NPV value are still positive but the value decline proportionately. In summary the three stages of broiler chicken meat supply chain are feasible and viable

to be implemented even after the environmental cost had been included in the cost of production, and hence, the study was successful in modelling environmental cost in the life cycle costing of broiler supply chain.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PRESTASI PERTUBUHAN PELADANG NEGERI TERHADAP RANTAIAN BEKALAN AYAM PEDAGING BERDASARKAN PENILAIAN KITAR HAYAT KOS ALAM SEKITAR DI JOHOR, MALAYSIA

Oleh

NUR SYAHIRAH BINTI SAMSUDDIN

Mac 2018

Pengerusi : Amir Hamzah Bin Sharaai, PhD
Fakulti : Pengajian Alam Sekitar

Malaysia telah mencapai tahap sara diri dalam industri ternakan ayam pedaging bagi tujuan sumber makanan. Namun, peningkatan populasi dan permintaan yang tinggi terhadap daging ayam telah memberi tekanan yang hebat terhadap industri ternakan ayam pedaging. Oleh itu, sektor pengeluaran ayam telah berkembang dengan pesatnya untuk menampung permintaan rakyat Malaysia terhadap produk ternakan ayam pedaging. Walaupun demikian, keadaan ini mencetuskan kewujudan sistem bersepadu yang dikenali sebagai rantai bekalan ayam pedaging. Oleh itu, kajian ini bertujuan untuk melihat prestasi rantai bekalan ayam pedaging bagi memastikan kelestarian pengeluaran dan juga alam sekitar. Metodologi yang digunakan dalam kajian ini adalah berdasarkan kerangka kerja umum penilaian kitar hayat kos alam sekitar yang terdiri daripada tiga peringkat: 1) definisi matlamat dan skop, 2) pengumpulan maklumat 3) pengenalpastian titik panas yang signifikan, 4) analisis sensitif. Struktur kos yang dihasilkan untuk perbelanjaan operasi, menunjukkan bahawa kos makanan adalah perbelanjaan utama dalam fasa penternakan dan fasa ladang kontrak. Sementara itu, untuk kilang pemprosesan, pembelian ayam hidup merupakan perbelanjaan utama. Kos alam sekitar yang signifikan dikesan ialah kos alam sekitar bagi kerosakan ekosistem. Keputusan penilaian prestasi menunjukkan bahawa terdapat penurunan kecil terhadap nilai NPV dan nilai IRR apabila kos persekitaran telah ditambah kepada kos pengeluaran. Namun, nilai NPV dan IRR bagi ketiga-tiga tahap ini adalah positif, walaupun kos alam sekitar termasuk di dalam kos pengeluaran. Analisis sensitif telah dijalankan dan keputusan menunjukkan bahawa apabila senario kos alam sekitar telah meningkat pada kadar 5%, 10%, dan 15%, nilai NPV masih positif walaupun nilai NPV menurun secara mendadak. Manakala, apabila senario kos alam sekitar menurun pada kadar 5%, 10% 15% nilai NPV meningkat dan kekal positif. Oleh itu, dari hasil kajian menunjukkan bahawa industri ternakan ayam berada dalam keadaan stabil dan penglibatan kos alam sekitar ke dalam kos pengeluaran dan tidak

menjejaskan keuntungan bagi industri ternakan ayam kecil . Oleh itu, satu model telah dicadangkan bagi memasukkan kos alam sekitar dalam amalan kos sedia ada.



ACKNOWLEDGEMENTS

I would first like to thank to Allah s.w.t for the good health and chance in successfully conducting this research till the end.

I would like to express my gratitude towards Fundamental Research Grant Fellowship (FRGS) for provide me chance and opportunity to successfully handle this project. Instead of that, big thanks to my supervisor Dr Amir Hamzah Bin Sharaai and my co-supervisor Professor Mohamad Mansor Bin Ismail for continuous support in terms of knowledge sharing and motivational support throughout this research journey. Special thanks also to master and Phd students under Dr. Amir Hamzah Bin Sharaai supervision and En. Iimas Bin Abdurofi (Prof Mansor 's Phd students) for knowledge sharing session and valuable discussion in finishing this research.

Appreciation to PPNJ Poultry and Meat Sdn. Bhd. & Medan Juara Sdn. Bhd. for giving permission to me to conduct data collection need for this research. Instead of that, I would like to thank Contract Farming Manager Mr. Shahrolnizam for accompanying me to all PPNJ farms and the contract farmers for good cooperation throughout the interview sessions.

Last and for most, I would like to express a lot of thanks to my parents Mr Samsuddin Redza and Mrs Fatimah Abu Salim, my siblings, my relatives for unconditional love and supports while conducting this research.

I certify that a Thesis Examination Committee has met on 9 March 2018 to conduct the final examination of Nur Syahirah binti Samsuddin on her thesis entitled "Performance of a State Farmers' Organization on Broiler Supply Chain Based on Environmental Life Cycle Costing in Johor, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Latifah binti Abd Manaf, PhD

Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Amin Mahir bin Abdullah, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Sumiani Yusoff, PhD

Associate Professor
University of Malaya
Malaysia
(External Examiner)



RUSLI HAJI ABDULLAH, PhD

Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 30 July 2018

This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Amir Hamzah Bin Sharaai, PhD

Senior Lecturer
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Mohd Mansor Bin Ismail, PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

ROBIAH BINTI YUNUS, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software

Signature: _____ Date: _____

Name and Matric. No.: Nur Syahirah Binti Samsuddin, GS40815

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) were adhered to.

Signature: _____
Name of Chairman
of Supervisory
Committee: Dr. Amir Hamzah Bin Sharaai

Signature: _____
Name of Member
of Supervisory
Committee: Professor Dr. Mohd Mansor Bin Ismail

TABLE OF CONTENTS

	Page
ABSTRACT	i
ABSTRAK	iii
ACKNOWLEDGEMENTS	v
APPROVAL	vi
DECLARATION	viii
LIST OF TABLES	xiv
LIST OF FIGURES	xvi
LIST OF APPENDICES	xviii
LIST OF EQUATIONS	xix
LIST OF ABBREVIATIONS	xx
CHAPTER	
1 INTRODUCTION	1
1.1 Chicken Meat Production System Trends and Status in Malaysia	1
1.2 Problem Statement	7
1.3 Objectives	8
1.3.1 The General Objectives	8
1.3.2 The Focus Objectives	8
1.4 Research Questions	9
1.5 Thesis Organization	9
1.6 Scope of Study	10
1.6.1 Breeder Farm	11
1.6.2 Contract Farming	12
1.6.3 Processing Plant	14
1.7 Significant of Studies	15
2 LITERATURE REVIEW	16
2.1 Introduction	16
2.2 Global Poultry Production and Food Security Concern for Demand on Poultry Meat Supply	16
2.3 Life Cycle Assessment in Decision Making Process	18
2.4 Life Cycle Costing as a Supporting Tool in Decision Making	20
2.5 Environmental Life Cycle Costing as Efficient Tools of Sustainability Assessment	22
2.6 Profit Function Model in Broiler Chicken Meat Production	25
2.7 Conclusion	26

3	MATERIALS AND METHODS	27
3.1	Introduction	27
3.2	Life Cycle Assessment	29
3.2.1	Goal and Scope Definition	30
3.2.1.1	Goal of the Study	30
3.2.2	Scope of Studies	32
3.2.2.1	System Boundaries of the Study	32
3.2.2.2	Functional and Functional Unit	33
3.2.2.3	Allocation	33
3.2.3	Life Cycle Inventory (LCI) phase	35
3.2.3.1	Preparing for Data Collection	36
3.2.3.2	Data Collection	38
3.2.3.3	Data Validation	38
3.2.3.4	Relating Data and Data Aggregation	38
3.2.3.5	Refining System Boundaries	39
3.2.4	Life Cycle Impact Assessment	39
3.2.4.1	Characterization	42
3.2.4.2	Normalization and Weighting	42
3.2.4.3	Weighting	43
3.2.5	SimaPro 8.0	43
3.2.6	Interpretation	43
3.3	Life Cycle Costing	43
3.3.1	Define The Scope of Decision / Option	44
3.3.2	Identify The Relevant Cost and Saving	44
3.3.3	Financial Appraisal Analysis	45
3.3.4	Interpretation	46
3.4	Environmental Life Cycle Costing	46
3.4.1	Goal and Scope Definition	47
3.4.2	Information Gathering	47
3.4.2.1	Eco cost Midpoint Table	48
3.4.2.2	Ecocost 2012 data on emissions and resources depletion	49
3.4.3	Identification and Interpretation of Hotspot	49
3.4.4	Sensitivity Analysis	49
3.5	Profit Function Modeling	50
3.5.1	Multiple Regression Analysis	50
3.6	Conclusions	52
4	RESULTS AND DISCUSSION	54
4.1	Introduction	54
4.2	Cost Structure for Broiler Chicken Meat Supply Chain	54
4.2.1	Capital Expenditures of Broiler Chicken Meat Supply Chain	55
4.2.1.1	Capital Expenditures of Breeder Farm	55
4.2.1.2	Capital Expenditures of Broiler Contract Farm	57
4.2.1.3	Capital Expenditures of Processing Plant	58
4.2.2	Operational Expenditures for Broiler Chicken Meat	

	Supply Chain	59
4.2.2.1	Operational Expenditure for Breeder Farm	59
4.2.2.2	Operational Expenditure of Broiler Contract Farming	61
4.2.2.3	Operational Expenditures for Processing Plant	62
4.2.3	Environmental Cost of Broiler Chicken Meat Supply Chain	63
4.2.3.1(a)	Potential Environmental Midpoint Impact from Breeder Farm	64
4.2.3.1(b)	Potential Environmental Midpoint Impact from Broiler Contract Farm	65
4.2.3.1(c)	Potential Environmental Midpoint Impact from Processing Plant	65
4.2.3.1(d)	Contribution of Every Stages in Broiler Chicken Meat Supply Chain towards Environmental Impacts	66
4.2.3.1(e)	Overall Process Involved in Broiler Chicken Meat Supply Chain towards Environmental Impacts	67
4.2.3.1(f)	Environmental Impact Contribution for Overall Process Involved in Broiler Chicken Meat Supply Chain	68
4.2.3.1(g)	Contribution of Every Stages in Broiler Chicken Meat Supply Chain towards Environmental Impacts	68
4.2.3.1(h)	Process Contributions in Environmental Impacts of Broiler Chicken Meat Supply Chain	69
4.2.3.1(i)	Environmental Midpoint Impact Contribution for Process Involved in Broiler Chicken Meat Supply Chain	70
4.2.3.1(j)	Single Score for Every Stages in Broiler Chicken Meat Supply Chain	71
4.2.3.1(k)	Single Score Results for Environmental Impacts in Overall Process of Broiler Chicken Meat Supply Chain	72
4.2.3.2	Environmental Cost for Broiler Chicken Meat Supply Chain	73
4.3	Performance Evaluation of Broiler Chicken Meat Supply Chain	77
4.3.1	Analysis of Performance Based on Net Present Value (NPV) of Broiler Chicken Meat Supply Chain	77
4.3.2	Analysis of Performance Based on Internal Rate of Return (IRR) of Broiler Chicken Meat Supply Chain	78
4.3.3	Analysis of Performance Based on Payback Period (PBP) of Broiler Chicken Meat Supply Chain	79
4.3.4	Sensitivity Analysis of Broiler Chicken Meat Supply Chain	80
4.4	Profit Function Model	83

5	CONCLUSION AND RECOMMENDATION FOR FUTURE RESEARCH	84
5.1	Conclusion	84
5.2	Recommendations for Future Research	84
	REFERENCES	86
	APPENDICES	91
	BIODATA OF STUDENT	121



LIST OF TABLES

Table		Page
1	The Profile of Broiler Chicken Sector in Malaysia	1
2	The Description of Broiler Chicken Meat Supply Chain	3
3	The Involvement of Integrated Players in Broiler Supply Chain in Malaysia	4
4	The SKLT Scheme Price and Incentives	14
5	World Balance According to The Meat Types	16
6	The Scenarios of Poultry Production in Developing and Developed Countries	17
7	The Literature on LCA	19
8	The Types of LCC Coverage	20
9	Research on LCC	21
10	The LCA Inventory Data Sheet	37
11	LCC Inventory Data Sheet Section Details	37
12	Data Collection Activities	38
13	The Translation of Life Cycle Inventory for The Research	40
14	Impacts Categories and Units	41
15	The Midpoint Table for Ecocost	48
16	Capital Expenditure for Breeder Farm	56
17	Capital Expenditure for Broiler Contract Farm	57
18	Capital Expenditure for Processing Plant	59
19	Operational Expenditure for Breeder Farm	60
20	Operational Expenses of Broiler Contract Farm	61
21	Operational Expenditure for Processing Plant	62

22	The Environmental Cost of Midpoint Impact Results for Breeder Farm	73
23	The Environmental Cost of Endpoint Impact for Breeder Farm	74
24	Total Environmental Cost of Midpoint Impact for Broiler Contract Farm	75
25	Environmental Cost of Endpoint Impact for Broiler Contract Farm	75
26	The Environmental Cost of Midpoint Impact Results for Processing Plant	76
27	The Environmental Cost of Endpoint Impact for Processing Plant	76
28	The Multiple Regression Test for Profit Model Function	83

LIST OF FIGURES

Figure		Page
1	The Theoretical Framework of Study	10
2	Breeder Farming Activities	12
3	SKLT Scheme Activities	13
4	Sustainability Venn's Diagram	23
5	The Types of LCC	24
6	The Research Study Framework	29
7	LCA Framework	30
8	Research System Boundaries	32
9	The Actual Process of Broiler Chicken Meat Supply Chain	34
10	The Allocated Process for The Study Broiler Chicken Meat Supply Chain	35
11	The Life Cycle Inventory (LCI) Phase	36
12	The Life Cycle Costing Framework	44
13	The Steps in Conducting ELCC	47
14	Percentage of Capital Expenditure for Breeder Farm	56
15	Percentage of Capital Expenditure for Broiler Contract Farm	58
16	Percentage of Capital Expenditure for Processing Plant	59
17	Percentage of Operational Expenditure for Breeder Farm	60
18	Percentage of Operational Expenditure for Broiler Contract Farm	62
19	Percentage of Operational Expenses for Processing Plant	63
20	Relative Contribution of Process (in %) Towards Environmental Impact of Breeder Farm	64

21	Relative Contribution of Processs (in%) Towards Environmental Impact of Contract Farm	65
22	Relative Contribution of Processs (in%) Towards Environmental Impact of Processing Plant	66
23	Relative Contribution of Stages in Broiler Chicken Meat Supply Chain (in%) Towards Environmental Impacts	67
24	Relative Contribution (in %) From Overall Process Involved in Broiler Chicken Meat Supply Chain Towards Environmental Impacts	67
25	Relative Contribution of Environmental Impact (in%) in Overall Process of Broiler Chicken Meat Supply Chain	68
26	Contribution of Every Stages in Broiler Chicken Meat Supply Chain Towards Environmental Impacts	69
27	Contribution of Process Involved in Environmental Midpoint Impact Broiler Chicken Meat Supply Chain	70
28	Relative Contribution in % From The Process Involved in Broiler Chicken Meat Supply Chain	71
29	Single Score for Every Stages in Broiler Chicken Meat Supply Chain	72
30	Single Score for Process Involved in Broiler Chicken Meat Supply Chain	72
31	The Comparison of NPV Results for Broiler Chicken Meat Supply Chain With or Without Environmental Cost	77
32	The Comparison of IRR Results for Broiler Chicken Meat Supply Chain With or Without Environmental Cost	79
33	The Comparison of PBP Results for Broiler Chicken Meat Supply Chain With or Without Environmental Cost	80
34	The Sensitivity Analysis Towards NPV Value with The Increase and Decrease of Environmental Cost (Breeder Farm)	81
35	The Sensitivity Analysis Towards NPV Value with The Increase and Decrease of Environmental Cost (Broiler Contract Farm)	82
36	The Sensitivity Analysis Towards NPV Value with The Increase and Decrease of Environmental Cost (Processing Plant)	82

LIST OF APPENDICES

Appendix		Page
A1	PPNJ Preliminary Visit Letter	91
A2	PPNJ Data Collection Letter 1	92
A3	PPNJ Data Collection Letter 2	93
A4	PPNJ Data Collection Letter 3	94
B1	LCC Inventory Data Sheet for Farm	95
B2	LCC Inventory Data Sheet for Contract Farms	103
B3	LCC Inventory Data Sheet for Processing Plant	107
C1	Environmental Costs for Breeder Farm	113
C2	Environmental Costs for Contract Farm	114
C3	Environmental Costs for Processing Plant	116
C4	The Performance Evaluation for Breeder Farm	117
C5	The Performance Evaluation for Contract Farm	117
C6	The Performance Evaluation for Processing Plant	117
C7	The Sensitivity Analysis for Breeder Farm	118
C8	The Sensitivity Analysis for Contract Farm	118
C9	The Sensitivity Analysis for Processing Plant	118
C10	The Model Database for Multiple Regression Analysis	119
C11	Normality Histogram for Model	120

LIST OF EQUATIONS

Equation		Page
1	The Functional Unit Calculation	39
2	The Calculation for Characterisation	42
3	The Calculation for Normalization	42
4	The Calculation for Net Present Value (NPV)	45
5	The Calculation for Internal Rate of Return (IRR)	45
6	The Calculation for Payback Period (PBP)	46
7	The Profit Function Model	50

LIST OF ABBREVIATIONS

LCA	Life Cycle Assessment
LCIA	Life Cycle Impact Assessment
LCC	Life Cycle Costing
ELCC	Environmental Life Cycle Costing
NPV	Net Present Values
IRR	Internal Rate of Return
NAP	National Agriculture Policy
EoL	End of Life
ADP	Acidification Potential
FAO	Food Agriculture Organization
VHM	Veterinary Health Mark
SSL	Self Sufficiency Level
SLCC	Social Life Cycle Costing
FCR	Food Conversion Rate
SETAC	Societal of Environmental Toxicology and Chemistry
eq	Equivalent
ITA	Incentives Tax Allowance
ITE	Incentives Tax Exemption
TETP/FAETP	Terrestrial /Fresh Water Ecotoxicity Potential
GWP	Global Warming Potential
HTP	Human Toxicity Potential
POFP	Photo Ozone Creation Potential
PBP	Payback Period

MRD	Material Resources Depletion
FFD	Fossil Fuels Depletion
MT	Million Ton
SKLT	Skim Kemahiran Latihan Ternakan
PPNJ	Persatuan Peladang Negeri Johor
GAP	Good Agriculture Practice
GAHP	Good Animal Husbandary Practice



CHAPTER 1

INTRODUCTION

1.1 Chicken Meat Production System Trends and Status in Malaysia

Poultry industry in Malaysia had evolved from small scale backyard production into domestic and modern scale production due to the increasing demand for poultry products. In Malaysia, poultry is the largest component of livestock in providing sources of protein among Malaysian citizen. Chicken had a significant production of all poultry, 94% of poultry production in Malaysia consisted of chickens, followed by ducks of about 5%, while geese, turkeys and quails comprised 1% of the total poultry production (Fatimah et al.,2007)

Currently, the poultry industry in Malaysia supplies 81% of protein source for the domestic market. According to Department of Veterinary Services, Malaysia exports poultry products to Singapore, Brunei, Hong Kong and Japan. There are several supporting factors that led to the upsurge of poultry production in Malaysia, namely the high quality of breeds, highly efficient integrated system, competent veterinary services, and effective regulation and enforcement in place. Furthermore, most of poultry products such as chicken meat is considered socially acceptable given the absence of dietary prohibition imposed by local culture and religious norms except for vegetarian. In Malaysia, there are two systems involved in broiler chicken industry: 1) independent farmers and 2) contract farmers. The former is usually performed by farmers with large capital who raise and retail their chickens by themselves. Contract farming, on the other hand, is generally conducted by integrator or partial integrator. It also involved cooperation between integrator and small farmers, by which the former provides technical support in farming and continuous platform markets for the farmers. It is considered as an alternative production system for small farmers that can ensure continuous supply of broiler chicken meat to the markets.

Table 1 : The Profile of Broiler Chicken Sector in Malaysia

	No of Companies	No. of Farms	Populations (m)
Grand Broiler Parent Stock	4	8	0.30
Broiler Parent Stock	23	79	5.34
Common Broiler	Individual/ Contract	2562	118.5

(Sources: Department of Veterinary Services Malaysia, 2014)

Based on Table 1, until 2014, there are 79 broiler parent stock farms with high production scale handled by 23 integrators and non-integrators, while there are about 2562 common broiler farms handled by independent and contract farmers.

According to the statistics from Department of Veterinary Services Malaysia 2014, about 1.8 million broiler chicken's meat are produced per day in Malaysia. About 70 % of chicken meats produce daily are sold at the wet market for domestic use while 7.05% from production are exported to Hong Kong, Brunei Darussalam, Singapore and Japan. Meanwhile, there are about 45,000 MT of chicken cuts and 1,000 MT of whole chicken are imported in 2014. Generally, Malaysia is able to contain self-sufficient in poultry production industry with lower amount of imported poultry entering the Malaysian market. The broiler production chain in Malaysia is fully developed due to involvement from private sector, as well as government assistance in stages of the supply chain which comprised of 1) raw material, 2) breeding and growing, 3) processing, and 4) distribution and retail. Table 2 shows the descriptions of four important stages in broiler chain production.

Table 2 : The Description of Broiler Chicken Meat Supply Chain

Raw Material	Breeding & Growing			Processing		Distribution & Retail	
Feed Milling	Grandparent Stock	Parent Stock	Broiler Farm	Primary Processing	Secondary Processing	Distribution	Retail
Process: Blend grains in specific proportions, add nutrients and required medication	Process: Breed and raise GPS, for mating to produce parent stock	Process: Breeding of parent stock, to be mated to produce broiler day-old-chicks	Process: Raising day-old-chicks into broilers in approx. 6 weeks ~2kg per bird	Process: Slaughter, draining, defeathering, evisceration, removal of head and feet	Process: Recovery of usable meat and fat, recombine into desired solid form and cooking	Process: Wholesale and distribution to final retail outlets and restaurants	Process: Retail of chickens' product in wet markets, hyper/supermarkets
Products/ services: Poultry feed, for specific phases: Starter, grower, finisher	Products/ services: Poultry feed, for specific phases: Starter, grower, finisher	Products/ Services: Broiler day-old chicks	Products/ services: Live broilers of specified weight	Products/ services: Processed chicken: slaughtered, de-feathered and eviscerated	Products/ services: Further processed chicken: Nuggets, sausages, chicken balls, canned food	Products/ services: Processed chickens and cut parts, further processed chickens, canned food	Products/ services: Processed chickens and cut parts, further processed chickens, canned food

(Sources: Department of Veterinary Services Malaysia, 2014)

Table 3 : The Involvement of Integrated Players in Broiler Supply Chain in Malaysia

Process	Feed Milling	Grand Parent Stock	Parent Stock	Broiler Farm	Distribution	Retail	Distribution
Company							
1. Leong Hup	/	/	/	/	/	/	/
2. CP Farm	/	/	/	/	/	/	/
3. Sinmah	/		/	/	/	/	/
4. Ayamas	/		/	/	/	/	/
5. Dindings	/		/	/	/	/	/
6. Huat Lai	/	/	/	/	/		
7. Lay Hong	/		/	/	/	/	/
8. Pin Wee	/		/	/	/	/	/
9. CAB		/	/	/	/	/	/
10.FFM Farms	/		/	/		/	

(Sources: Department of Veterinary Services Malaysia, 2014)

In Malaysia, it has been estimated about eight chicken integrators that might have a complete broiler supply chain, while the other 15 non-integrators only have one or two broiler supply chain. Table 3 shows the involvement of integrated players throughout the broiler supply chain in Malaysia. It has been estimated about 6% of the total production of live birds per day (108,000) in Malaysia is exported, while the larger portion of the total production of live birds per day which is 94% (1,692,000) is used specifically for local consumption. Of the 94% of total live bird production, 25% entered the wet market for processing and sold to the small food operator and localized retailers. Meanwhile, 34% of the live birds are processed by micro-processor non VHM and then sold to localized retailer for further processing, hypermarket and small food operator. It has been reported that 35% of total number of live birds produce per day are sent for processing using VHM micro-processor. There are three types of chicken meat that are produced by processing plant and then sold to end user, namely standard meat, super and special cuts.

Increase in demand for poultry products also led to the increase in demand for feeds. The basic ingredients of poultry feed usually consist of maize, wheat and soy. It has been noted that major ingredients of poultry feed experienced competition in the market with demands for human foods especially in poor countries such as Ethiopia (Mengesha, 2012). In fact, the world has witnessed the price hike of rice, maize and wheat on the international market during the global food crisis. Consequently, this could hurt the poultry meat supply driven by food insecurity, thereby affecting the prices of poultry meat since the poultry production depended heavily on feed for broiler chicken growth. Therefore, precautionary actions toward food crisis involving measurement and monitoring aspects of food security are vital to ensure sustainability of material resources required in the production of broiler chicken will not affect the poultry meat supply. There are four crucial parameters to ensure a given country achieve sustainable food security, namely food supply readiness, ability of the people to purchase food and supply of nutritious food (FAO, 1996). Generally, changes in food prices affected the purchasing capacity of major basic necessities such as oil, rice, wheat flour or sugar among low and medium income (Halim, 2015). In addition to the aforementioned basic necessities, chicken meat supply is also included in the primary focus for healthy and nutritious food supply.

It has been noted previously that the fluctuation in feed supply for poultry production sector due to the increase in price of feed ingredients. In addition to the fact that local consumption comprising 94% of the total chicken meat production, it is obvious that chicken meat has become a staple for protein sources among Malaysian. A hike in price of chicken meat in the market will undoubtedly affect accessibility of chicken meat among medium and low-income household. Consequently, access to acquiring basic necessities for nutritious food supply too might be affected.

In reference to the aforementioned arguments, a gallant effort is made to expanding the poultry industry in Malaysia to overcome the food insecurity of chicken meat supply. The high volume of poultry farms might create competition in acquiring scarce resources such as water, space and feed. Therefore, these resources should be

protected throughout the supply chain system to sustain a continuous supply of chicken meat. As important it is to cater the food demand among Malaysians, the environmental aspects ought to be included as one of the benchmarking for continuous food supply. The establishment of a specific law called Environmental Quality Act 1974 aptly handle issues regarding environmental protection in Malaysia. The law includes prevention, abatement, pollution control and enhancing the environment, and other purposes connected therewith. Although, the listed general guidance in EQA 1974 for environmental protection presented lack of depth and specificity for regulation in an industry. Currently, studies at identifying the environmental impact within the supply chain of poultry industry is also lacking.

Supply chain management of chicken meat production includes the feed plantation and milling, breeder farming, hatchery, broiler farming, slaughterhouse and processing plant, distribution and marketing of chicken meat. The “cradle to grave” concept of a product is in fact, based on Life Cycle Assessment (LCA) study. LCA is widely used in poultry, livestock and food production in assessing the environmental impact from their regular activities which starts from material extraction, manufacturing, end of life cycle. The LCA study includes assessment of the environmental impact of production through the supply chain management. The unexpected economic encounter in the supply chain management resulted in poorly received support of decisions made based on LCA since business entrepreneurs are mainly motivated by profit investment. The Life Cycle Costing (LCC) includes assessment of all costs involved within the production activities. It is widely used in procuring assets such as buildings and machinery. The Environmental Life Cycle Costing (ELCC) is established by combining the two approaches of LCA and LCC which could improve the power of decision making for environmental aspect in the industry. Although, one drawback should be noted as the reference and data availability remained scant due to the lack of study using the combined approach.

Based on the current status of chicken meat production, Malaysia has a well-structured and organized poultry sector. The latter required special attention since almost Malaysian consumed poultry product as part of their daily diet. As the poultry industry is affected by global food crisis between 2006 and 2008, prices of feed sources especially maize and soybean increased significantly with the maize price reportedly doubled in one and half year after August 2006 (Chand, 2008). Thus, this situation also extended to the food insecurity for chicken meat due to the increase price of chicken meat, thereby affecting affordability among low and medium income household to provide nutritious food supply for their family.

Therefore, from this situation the ELCC approach is the complement approach to deal with. The non integrators do their roles in supporting the integrators company in supplying sufficient chicken meat and chicken further process product in the market. Even non integrators do not have complete chicken supply chain production but the non-integrators company really helps in coping the demand for chicken supply chain in Malaysia.

Presently, there are many initiatives such as schemes and loans that are provided by Malaysian governments and agencies in ensuring the continuous supply of poultry meat in the markets. While the growth of poultry industry is blooming vigorously, the situation has created a competition for natural resources that is becoming scarce. Furthermore, there is also the tendency of pollution happening in between and if the environmental aspects are continued to be neglected, it could hurt the already scarce resources. Hence, it is important to ensure the environmental aspects had been protected to ensure the continuous supply of poultry meat.

Therefore, from this situation the ELCC approach is the complement approach to deal with. The non integrators do their roles in supporting the integrators company in supplying sufficient chicken meat and chicken further process product in the market. Even with non integrators that do not have complete chicken supply chain production but the non-integrators company could help in coping the demand for chicken supply chain in Malaysia.

Hence, this study will highlight on the performance of broiler supply chain in order to ensure sustainable production and environment.

1.2 Problem Statement

The livestock meat output in Malaysia had achieved their self sufficiency level, according to the Department of Veterinary Services of Malaysia, throughout four years from 2012 until 2015, mutton had been recorded as the highest output production estimated about 18,408.2 million tonnes across four years. Poultry meat recorded as second highest output production estimated about 6,019.17 million tons from year 2012 until 2015. Currently, Malaysia had achieved self sufficiency level (SSL) of poultry meat production estimated about 128 percent. Although the country is self-sufficient in poultry meat, there are still applicable issues regarding the sustainability of industry, accessibility of poultry meat and optimal utilisation of resources.

Presently, poultry industry in Malaysia had been manage in two ways known as vertically integrated system and independent farmers. Vertically integrated system had been conducted by integrator, the major commercial player of broiler production in terms of broiler supply chain. This system introduces contract farming scheme which offers all basic inputs (i.e. day-old chicks, feed rations, and veterinary service) to the farmer who agreed to sell back the fully grown broilers to the integrator at mutually agreed prices (Bisant Kaur, Nitty Hirawatty Kamarulzaman, and Nur Amalina Hamzah, 2015). The previous study conducted by Sulaiman, 2001 show that, the contract farmers dominated supplied estimated 55 percent of broiler output in year 2001 and the remaining 45 percent come from the independent farmers. Therefore, it show that vertically integrated broiler production supply chain have a big potential in ensuring the continuous supply of broiler chicken meat in Malaysia compared to independent broiler production. However, the issues regarding the low margin

between the production cost and sales per bird, the higher feed cost, low of net returns in broiler production, and disease outbreak will limit the interest for new investors. Therefore, this study tend to assess the profitability of broiler supply chain in order to ensure it competency to remain sustain for continuous supply of chicken meat in Malaysia.

Food industry is one of the largest industries in the world that significant in resources and energy consumption. Broiler supply chain have to compete on scarce resources such as air, water, and land. Therefore, environmental protection is crucial in order to ensure enough resources need for continuous supply of broiler chicken meat in the future. The interest in environmentally supply chain management has risen considerably in recent years (Paulina Golinska and Carlos Andres Romano, 2012). Instead of that, the implementation of green marketing principle with bussiness system currently being the hot issues in globalization process of the economy, due to the enormous potential in obtaining the viable competitive advantage (Kirilova & Vaklieva-Bancheva, 2017). However, in order to integrate the green marketing and bussiness system is really far from concern since the difficulties in estimation of environmental impact and cost produce by the firm. Therefore, this study will suggest the adoption of environmental cost in the broiler supply chain.

1.3 Objectives

1.3.1 The General Objectives

The general objective of this study is to evaluate the performance of broiler supply chain with the inclusion of environmental costing.

1.3.2 The Focus Objectives

There are three focus objectives of this study stated as below:

1. To define the cost structure of broiler supply chain such as capital expenditures, operational expenditures and environmental cost.
2. To assess the profitability of broiler supply chain based on three (3) financial indicator: IRR, NPV and Payback Period with and without environmental cost.
3. To suggest the inclusion of environmental cost in the existing costing practice of broiler contract farms through profit function model.

1.4 Research Questions

The research question had been develop based from the objective of this study:

1. What are the total cost involved for broiler supply chain?
2. How is the profitability of broiler supply chain either with and without environmental cost based on the value of NPV, IRR, and Payback Period across 10 years?
3. Do the inclusions of environmental cost will affect the profit earn by the broiler contract farmers?

1.5 Thesis Organization

This section will briefly describe the pathways on measuring the performance of broiler chicken meat supply chain.

Broiler chicken meat industry had been well established in Malaysia in year 1980. Increase in domestic demand of poultry meat in Malaysia, provide greater pressure on the supply. Therefore, broiler chicken meat industry players had to compete on scarce resources such as air, water, and land. Instead of that, the intensity of broiler industry in order to fullfill the domestic demand on poultry meat, the industry tend to pollute the environment along the chain of production. Currently, the environmental issues become serious attention in global industries including broiler chicken meat supply chain. However, the justification of environmental impact in specific number is still unreveal. Therefore, in this study Life Cycle Assessment (LCA) had been used to assess the environmental impact in specific number along the broiler chicken meat supply chain.

Practically in business management, all the business owner focus on the profit earning and return on their investment. Therefore, financial appraisal is crucial in order to monitor the feasibility of their business project, and decision making throughout the supply chain management. Financial appraisal is a traditional approach of project evaluation, that treats the individual projects as isolated investment opportunities in which it is crucial to make decision regarding the acceptance or rejection of a project (Nuno Mountinho and MDS Lopes, 2011).

Financial appraisal or also known as financial evaluation is the best tools represent the Life Cycle Costing (LCC).

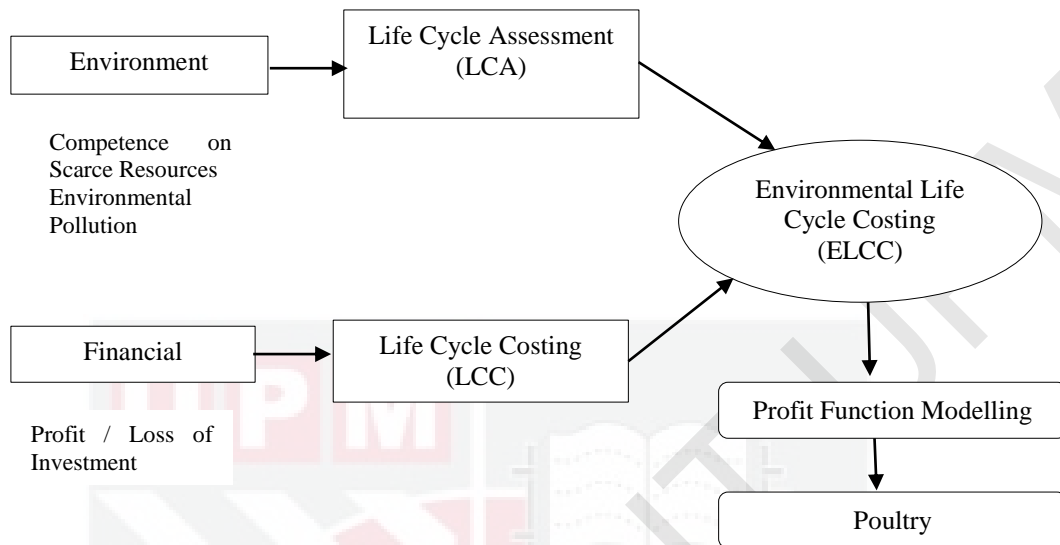


Figure 1 : The Theoretical Framework of Study

Those two method had been combined together and known as Environmental Life Cycle Costing (ELCC). ELCC involve the assessment of total cost involve in the production including the externalities that had been turned into monetary value. In this case, the externalities highlighted for this research is the environmental burden cost along the supply chain. The environmental cost had been calculated and the inclusion of environmental cost in the production cost.

1.6 Scope of Study

The broiler chicken supply chain management is vertically integrated. The vertically integrated broiler chicken supply chain involves the combination of production stages or subsystem that involves in broiler chicken meat production such as the feedmill, the breeder farm and hatchery, farming, processing and distribution.

PPNJ is one of broiler supply chain in Johor which had been selected for this study. PPNJ broiler supply chain consists of four subsystems namely; breeder farm and hatchery, farming, processing and distribution. However, for the scope of this study only three subsystems had been focus on. Below are the detail decriptions of three subsystems involves in this study.

1.6.1 Breeder Farm

For this research Medan Juara Sdn. Bhd had been a sample of study. Medan Juara Sdn Bhd had been established due to cooperation of Persatuan Peladang Negeri Johor (PPNJ) and National Farmers Society (NAFAS). Medan Juara Sdn. Bhd supply the broiler chicks to PPNJ contract farmers. Estimated about 4.5 million number of chicks had been produced per year by PPNJ Poultry and Meat Sdn. Bhd. Breeder Farm is an important stage in produce fertile eggs that will be hatch in hatchery for broiler chicks supply to the broiler chicken farmers. There are seven stages in breeder farming activities: 1) Brooding, 2) Growing, 3) Mating, 4) Collection, 5) Incubation and Hatching 6) Sexing, and 7) DOC delivery.

The one day old grandparents stock (GPS) had been placed in the coops and the brooding phase had been conducted. In brooding phase, the female and male GPS will be separated for five weeks. Brooding is the most sensitive period because the birds changing from the immature thermo regulation system into a mature one (Henrique, 2015). The second stage is growing stages, growing stages happens between 6 to 24 weeks. During this stages the female and male GPS still being separated and the feed for both GPS had been control. The third stage is mating, the time period for mating phase estimated within 25 weeks to 66 weeks. Mating process had been done by mate 10% of cockerels to a group of hens to achieve the fertility rate. Then, within this period the hens will laying eggs. The fourth stages is collecting, in this stages the fertile eggs will be collecting everyday after laying due to hygiene factors and heat of the day. The laying eggs then will be sent to the hatchery. The fifth stages is incubation and hatching. Incubation and hatching take place at the hatchery. The eggs collected and sent to the hatchery had been set in the tray mark with shed of origins so that the eggs can be traced back. Hatching process had been monitored well to produce quality chicks. The sixth stage is sexing. Sexing is the process separation of one day old chicks according to their sex. The one day old chicks which had been separated had been placed into the container and delivered to the contract farmers of PPNJ Poultry and Meat Sdn Bhd. **Figure 2** represent the seven stages in breeder farm activities.

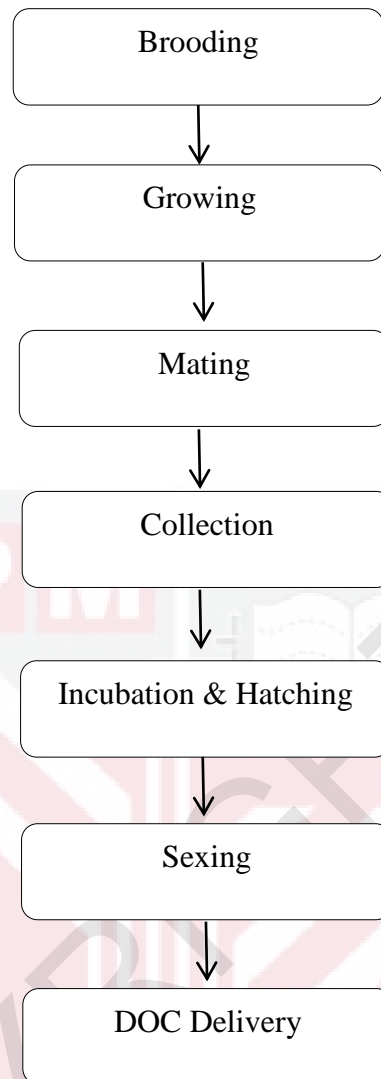


Figure 2 : Breeder Farming Activities

1.6.2 Contract Farming

Contract farming is an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices (Eaton & Shepherd, 2001). The contract farming activities had been conducted by PPNJ Poultry and Meat Sdn Bhd under Supervise Farm Contract Scheme (SKLT). This scheme will provide unsecured credit facilities and benefits to finance input supply, provision of basic facilities and equipment supported by management advisory services. This scheme aims to improve members' living standards through increased quantity and quality of farm production. Figure 3 show the activities and service involved in SKLT scheme.

SKLT scheme core activities are providing supply of chick, feed and vaccination towards PPNJ contract farmers. Instead of that, through SKLT scheme support services for contract farmers such as the place where contract farmers will market their production, the technical services in terms of advise and guidance in raising the chicks, feed control, technology and etc.

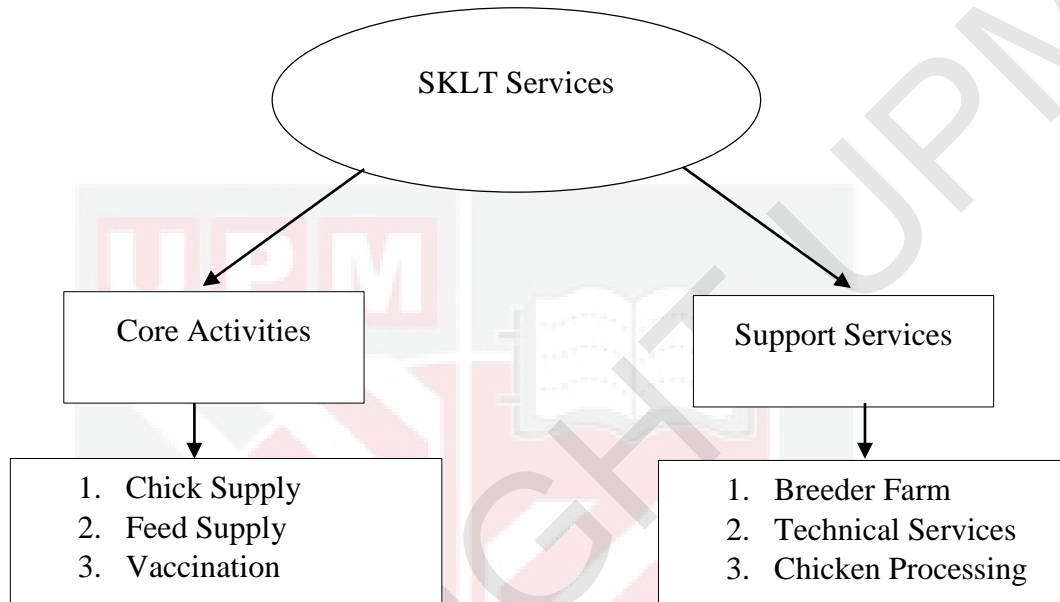


Figure 3 : SKLT Scheme Activities
 (Sources: PPNJ Poultry and Meat Sdn. Bhd. 2016)

SKLT scheme provide special price services and incentives for members. Starting from year 2015 SKLT members can buy DoC with RM 1.62 per bird. Feed cost had been fixed as stated below in the table. Rebate system had been introducing by PPNJ Poultry and Meat Sdn. Bhd towards SKLT members which means the DOC and feed cost will be rebate after SKLT members sold the harvest chicken to PPNJ Poultry and Meat Sdn. Bhd with RM 4.20/kg. The price for broiler chicken at farm is fix and the farmers are no affected due to decrease in chicken market price. Instead of that, the SKLT members will get incentive if the mortality rate is less than 5% which is about RM0.03/kg. **Table 4**, show the item, pricing, and incentives gain by the SKLT scheme members.

Table 4 : The SKLT Scheme Price and Incentives

No	Item	Price
1)	DOC	RM 1.60/bird
	Sexing	RM 0.02/bird
2)	a) Starter Feed	RM 89.50/bag
	b) Grower Feed	RM 87.50/bag
3)	Broiler	RM 4.20/kg (ex-farm)
4)	Incentive	Caught Live Chicken \geq 95 % : Incentives will be given at RM 0.03/kg

The farming stages involves three important subsystems: 1) incubation, 2) growth, and 3) harvest. The incubation will be done in two weeks for DOC, the temperature of the coops had been control and the broiler chicks had been given starter feeds. After two weeks old until 36 days the broiler chicks had been given vaccination and the growth had been monitor in terms of ideal weight and health, the grower feeds had been given to the broiler chicks. Harvest process had been done within 36 days old until 40 days' old, the processing plant division will help to catch the matured broiler chickens and send to the processing plant for slaughtering and further processing.

1.6.3 Processing Plant

Processing plant had been managing by processing division of PPNJ Poultry and Meat Sdn. Bhd. The processing plant responsible in processing 100% live chicken produced by SKLT scheme members. The processing plant be able to process estimated about 15,000 to 18,000 number of birds daily. Instead of producing the chicken meat, this processing plant also produce process chicken meat based product such as nugget, piece cuts, fried chicken, chicken satay, popcorn chicken, and marinated chicken. PPNJ Poultry and Meat Sdn. Bhd had rent the buildings and equipment from PPNJ Sdn. Bhd at RM 70,000 per year. There are 8 core process of processing plant: 1) Live Chicken Loading, 2) Weighing and Hanging, 3) Slaughtering and Halal Compliance Check, 4) Defeathering & Head and Legs Cut Off, 5) Evisceration, 6) Rotates Cooling Process, 7) Preparation, and 8) Packaging and Storage.

The matured live chicken that had been harvest from the farm was sent to the processing plant. The live chicken had been loading at the loading bay of the processing plant. Next, after the loading of live chicken weighing process take place and the weight had been recorded, the live chicken had been hanging at the hanging machine that have the rotating belts for slaughtering process. Then, after hanging the live chickens, the slaughtering process take place by using the sharp knife, after the slaughtering process done the slaughtered chickens had been passed through halal checks by Quality Assurance supervisor. The slaughtered chickens then passed through the boiled water to make the defeathering process much easier. Defeathering process is the process on taking out the feathers from the chicken. This process had been carried out by the three workers manually and the head and legs had been cut off. After that, the chickens once again had been hanging at the hanging machine with

rotating belts and then transferred to evisceration process. Evisceration process is a process involves the internal organ clearance, the internal organ then had been separated which might be useful and the non useful internal organ had been thrown away. After that, by using the rotating belts the chickens had been washed and ready for rotates and cooling process. After the cooling process, the chickens had been placed on the conveyor belts and separated and prepared according to the purposes product. The standard chicken meat had been directly pack and store in the storage fridge before distribution.

1.7 Significant of Studies

Chicken meat currently is essential protein sources for Malaysian. It has been widely accepted by most race and religious norm except for Buddhist or vegetarian. Eventhough, the chicken meat supply in Malaysia nowadays had achieved their self sufficient level, the broiler chicken meat industry in Malaysia facing competition in obtaining the scarce resources. Hence, it is important to ensure sustainable broiler chicken meat production at the same time protecting the scarce resources from depletion. Therefore, ELCC is the best environmental assessment approach in ensuring the sustainable production of broiler chicken meat supply chain and protect the environment. This study provides a suggestion on establishing of environmental funds in broiler chicken meat supply chain industry. Instead of that, this study will be a reference for polluters pay principle implementation. Furthermore, this study can be used as reference in establishing environmental rebates for broiler chicken meat supply chain firm. Last but not least, it is hopeful that this study can be used as reference for other studies that implement ELCC approach.

REFERENCES

- Alexander, K., Computer Aided Building Appraisal for the Design-in -use of Buildings Department of Architecture and Building Science, University of Strathclyde. Discussion paper, undated
- Ambler, E., S. Bailey, K. Kiff, A. Lang, T. Lee, R. Marsden, T., Simons D., Tibb, H., (2009). Food Future: Rethinking UK Strategy Chatham House London.
- Andersson K, Ohlsson T, Olsson P. Life cycle assessment (LCA) of food products and production systems. Trends Food Sci Technol 1994; 5:134–8.
- Anderson, M. K., Life cycle costing in manufacturing industries American Association of Cost Engineers Transactions, 1978, 348- 353
- Ashworth, A., Life-cycle costing: a practice tool. Cost Engineering, March 1989, 3, 8 11
- Barbera, L., Ma, A., Leon, P., and Marquez, A., 2012. A practical method for the maintainability assessment in industrial devices using indicators and specific attributes Reliability Engineering and System Safety 100, 84-92
- Bengtsson J, Seddon J. Cradle to retailer or quick service restaurant gate life cycle assessment of chicken products in Australia. J Clean Prod 2013; 41:291–300
- Bengt Steen, Carlson, R., Lyrstedt, F., Skantze, G., 2009. Sustainability management of businesses through eco-efficiency – an example. Center for Environmental Assessment of Product and Material Systems
- Bhatta, K. P, Ishida, A., Taniguchi, K., Sharma, R., 2008. Profitability and Sustainability of the Emerging Poultry Bussiness in Developing a Case of a Poultry Grower of Nepal. Munich Personal RePEc Archive.
- Bird, B E I, Costs in Use: A State of the Art Review Building Research Establishment, Garston: Watford, 1984.
- Castanheira, E.G., Dias, A.C., Arroja, L., Amaro, R., 2010. The environmental performance of milk production on a typical Portuguese dairy farm. Agric. Syst. 103, 498-507
- Cedeberg, C., Stadig, M., 2003. System expansion and allocation in life cycle assessment of milk and beef production. Int. J. Life Cycle Assess. 8, 350-356.
- Chand, R. 2008. The Global Food Crisis: Causes, Severity and Outlooks Economic and Political Weekly, 115-123.
- Curran, M.A. 1996. Environmental Life Cycle Assessment. Mc Graw Hill

- Davis, J., Sonesson, U., 2008. Life cycle assessment of integrated food chains-a Swedish case study of two chicken meals. *Int. J. Life Cycle Assess.* 13, 574-584
- da Silva VP, van der Werf HMG, Soares SR, Corson MS. Environmental impacts of French and Brazilian broiler chicken production scenarios: an LCA approach. *J Environ Manage* 2014; 133:222–31.
- de Vries, M., de Boer, I.J.M., 2010. Comparing environmental impacts for livestock products: a review of life cycle assessments. *Livest Sci.* 128, 1-11
- Dunk, A. S., 2004. Product Life Cycle Cost Analysis: the impact of customer profiling, competitive advantage, and quality of IS information. *Journal Management Accounting Research* 15, 401-414.
- Donohue, M. and Cunningham D.L., 2009. Effect of grain and oilseed meals on th cost of US poultry production. *Journal of Applied Poultry Research* 325-337
- Eric Korpi, Timo Ala- Risku, (2008) "Life cycle costing: a review of published case studies", *Managerial Auditing Journal*, Vol. 23 Issue: 3, pp.240-261
- Fullman, C Accuracy is the best policy for life cycle cost analysis. *Specifying Engineering*, March 1979, 41, 127 129
- Food Agriculture Organization, 2008. Food Security for Information and Action (Practical Guidelines). An Introduction to the Basic Concepts of Food Security, pp.1-3
- Food Agriculture Organization, 2011. Lesson from the World Food Crisis2006-2008.The State of Food Insecurity in the World. An Introduction to the Basic Concepts of Food Security, 21-31.
- Gerber, P., Wassenar, T., Rosales, M., Castel V., Steinfield, H., Environmental impacts of a changing livestock production: overview and discussion for a comparative assessment with other food production sectors *FAO Fisheries Proceedings*. No. 10. Rome, FAO. 2007. pp. 37–54
- Gluch, P. and Baumann, H. (2004). The Life Cycle Costing Approach: A Conceptual Discussions of Usefulness for Environmental Decision Making.*Journal of Building and Environment.* 39(5) 571-580.
- Godfray, H., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence., Muir., Pretty, J., Robinson, S., Thomas, S., Toulmin, C., 28 January, 2010. Food security: the challenge of feeding 9 billion people. *Science Express*.
- Gonzalez-Garcia S, Gomez-Ferna ´ndez Z, Dias AC, Feijoo G, Moreira MT, Arroja L. Life cycle assessment of broiler chicken production: a Portuguese case study. *J Clean Prod* 2014; 74:125–34.

- Hass, J., & Weir, M. (2007). *University Calculus*. Boston: Pearson Addison-Wesley
- Halim, N. A. (2015). Assessment of Food Security Challenges in Malaysia. *FFTC Agriculture Policy Articles*.
- Hunkeler, D., Lichtenvort, K., Rebitzer, G. (Eds.), 2008. *Environmental Life Cycle Costing*. SETAC, Pensacola, Florida
- Hospido, A., Moreira, M.T., Feijoo, G., 2003. Simplified life cycle assessment of Galician milk production. *Int. Dairy J.* 13, 783-796.
- Hopfenbeck, W. (1993), *The Green Management Revolution: Lessons in Environmental Excellence*, Prentice Hall, Englewood Cliffs, NJ.
- Jahan M. S., Asaduzzaman, M., Sarkar, A. K., 2006. Performance of Broiler Fed on Mash, Pellet and Crumble. *International Journal of Poultry Science*, 265-270.
- John C. V. Pezzey and Michael A. Toman, 2002. *The Economics of Sustainability: A Review of Journal Articles*• Discussion Paper 02-03
- Kalhor, T., Rajabipour, A., Akram, A., et al., 2016. Environmental impact assessment of chicken meat production using LCA. *Information Processing in Agriculture* 3(4), 262-271
- Katajajuuri, J.M., 2007. Experiences and Improvement Possibilities e LCA Case Study of Broiler Chicken Production. MTT Agrifood Research Finland, Biotechnology and Food Research, Food Ecology, Jokioinen, Finland. <http://www.lcm2007.org/paper/176.pdf> (accessed March 2013)
- Khan, M. Y., Jain, P. K., 2007. *Cost Accounting*. Tata Mc Grawhill Publishing Company Ltd. New Delhi
- Leinonen I, Williams AG, Wiseman J, Guy J, Kyriazakis I. Predicting the environmental impacts of chicken systems in the United Kingdom through a life-cycle assessment: broiler production systems. *Poultry Sci* 2012; 91:8–25
- Leff, E., 1995, *Green Production: Towards and Environmental Rationality*, Guilford Press
- Mengesha, M. 2012. The Issue of Feed Food Competition and the Chicken Production for the Demand of Food of Animal Origin. *Asian Journal of Poultry Science* 6, 31-43
- Misselhorn, A., Aggarwal, P., Ericksen, P., et al., 2012. A vision for attaining food security. *Current Opinion in Environmental Sustainability*. 4(1), 7-17
- Micheal, R., Kinney, and Cecily, A., Raiborn, 2010. *Cost Accounting: Foundations and Evaluation*. South Western CENGAGE Learning.

- Norris, G., 2001. Integrating Life Cycle Cost Analysis and LCA. *International Journal of Life Cycle Assessment*. 6(2), 118-120.
- Okano, K., 2001. Life Cycle Costing-An Approach to Life Cycle Cost Management: A Consideration from Historical Development. *Asia Pacific Review*, 317-341.
- Pelletier, N., 2008. Environmental performance in the US broiler poultry sector: life cycle energy use and greenhouse gas, ozone depleting, acidifying and eutrophying emissions. *Agric. Syst.* 98, 67-73.
- P. R. Hobbs, K. Sayre, R. Gupta, *Philos. Trans. R. Soc. London Ser. B Biol. Sci.* 363, 543 (2008).
- Ram Nidumolu, C.K. Prahalad, and M.R. Rangaswami. (2009). Id Why Sustainability Now is The Key Driver for Innovation. Retrieve from: <https://hbr.org/2009/09/why-sustainability-is-now-the-key-driver-of-innovation>
- Rich, C. Using life-cycle analysis to improve plant design. *Plant Engineering*, June 1978, 32, 151-154.
- Roy, P., Nei, D., Orisaka, T., Xu, Q., Okadome, H., Nakamura, N., Shiina, T., 2008. A review of life cycle assessment (LCA) on some food products. *J. Food Eng.* 90, 1-10.
- R. Majid. & S. Hassan, (2014). Performance of Broiler Contract Farmers; A case study in Perak, Malaysia. *UMK Procedia*, 1, 18-25.
- Samarakoon S.M.R. & Samarasinghe K., (2012). Strategies to improve the cost effectiveness of broiler production, *Tropical Agricultural Research*, 23(4), 338-346.
- Schmidt Rivera, X.C., Espinoza Orias, N., Azapagic, A., 2014. Life cycle environmental impacts of convenience food: comparison of ready and home-made meals. *J. Clean. Prod.* 73 (2014), 294-309
- Sharaai, A.H. 2017, *Nota Statistik dan SPSS Bahagian 2*. Fakulti Pengajian Alam Sekitar.
- Sharma, K.; Dutta, N.; Pattanaik, A. K.; Hasan, Q. Z., 2003. Replacement value of undecorticated sunflower meal as a supplement for milk production by crossbred cows and buffaloes in the Northern plains of India. *Trop. Anim. Health Prod.*, 35: 131-145
- Skinner, J.T., Waldroup, P. W., Waldroup, A.L. 2011. Effect of dietary nutrient density on the performance and carcass quality of broilers 42 to 49 days of age. *The Journal of Applied Poultry Research*, 367-372

- Shaikh, A.S. and Zala, Y.C. 2011. "Production Performance and Economic Appraisal of Broiler Farms in Anand district of Gujarat". *Agricultural Economics Research Review*, 24(2): 317-323.
- Seldon, M. R., *Life Cycle Costing: A Better Method of Government Procurement*. Westview Press: Boulder, Colorado, 1979
- Standardization, I. O., 2015. *ISO 9001 Moving from ISO 9001:2008 to ISO 9001:2015*, pp.1-8.
- Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., De Haan, C., 2006. *Livestock's Long Shadow: Environmental Issues and Options*. FAO, Rome, Italy
- Sullivan, T.F. 1992 *The Greening of American Business: Making Bottomline Sense of Environmental Responsibility*, Government Institutes
- Taylor, W B., The use of life cycle costing in acquiring physical assets. *Long Range Planning*, 1981, 14, 32-43
- Thevenot, A., Aubin, J. Tillard, E., & Vaysseries, J., (2012). Accounting for farm diversity in Life Cycle Assessment studies - the case of poultry production in a tropical island. *Journal of Cleaner Production* 5(7): 280-292.
- Tomlinson, I., 2013. Doubling of food production to feed 9 billion: A critical perspectives on a key discourse of food security. *Journal of Rural Studies*. 29, 81-90.
- Tongpool, R., Phanichavalit, N., Yuvaniyama, C., Mungcharoen, T., 2012. Improvement of the environmental performance of broiler feeds: a study cycle assessment. *J. Clean. Prod.* 35, 16-24
- T. Kuhlman. and J. Farrington 2010. What is Sustainability? *Journal of Sustainability*, 2: 3436-3448.
- Waner, S., & Costenoble, S. (2009). *Math for Business Analysis* (2nd ed.). Ohio: Cengage Learning.
- Wiibbenhorst, K. L., Life cycle costing for construction projects. *Long Range Planning*, 1986, 19, 87-97