

ADDIS ABABA UNIVERSITY
FACULTY OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
GRADUATE PROGRAM IN INDUSTRIAL ENGINEERING

**Internal supply chain improvement via production modeling
For large scale poultry farms**

By
Selamawit Fekade

Advisor
Dr. Gulilat Gatew

Co-Advisor
Mr. Yared Lemma

Submitted to the school of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Mechanical Engineering (Industrial Engineering)

JUNE 2016

ADDIS ABABA UNIVERSITY
FACULTY OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
GRADUATE PROGRAM IN INDUSTRIAL ENGINEERING

**Internal supply chain improvement via production modeling
For large scale poultry farms**

By
Selamawit Fekade

Approved by Board of Examiners:-

----- Chairman, Department of Graduate Committee	----- Signature	----- Date
Dr. Gulilat Gatew ----- Advisor	----- Signature	----- Date
Mr. Yared Lemma ----- Co-Advisor	----- Signature	----- Date
Dr. Ing. Eshetie Berhan ----- Internal Examiner	----- Signature	----- Date
----- External Examiner	----- Signature	----- Date

DECLARATION

I hereby declare that the work which is being presented in this thesis entitled “**Internal supply chain improvement via production modeling, For large scale poultry farms**” is original work of my own, has not been presented for a degree of any other university and all the resource of materials used for this thesis have been duly acknowledged.

Selamawit Fekade

Date

This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

Dr. Gulilat Gatew (Advisor)

Date

Mr. Yared Lemma (Co-advisor)

Date

ACKNOWLEDGEMENT

First I'd like to thank my Lord and savior Jesus Christ for giving me the opportunity, strength, and ability to complete this thesis. Following I would like to express my deepest gratitude to my advisor, Dr. Gulelat Gatew and co-advisor Ato Yared Lemma, without their support, encouragement, continuous follow up and advice I would certainly not have gone this far.

I am grateful to Dr. AregaYirdaw, CEO Midroc Ethiopia and my boss Ato Getachew Hagos, POO, Midroc Ethiopia for all the things that they have given me to complete this thesis. Also I would like to take the time to acknowledge Mr. Globler, Consultant and Poultry Association member, W/ro Atsede, Senior Agronomist, Ato Tigistu G/Tsion, Director Material Management and all participants specially who work on poultry farms, for their help by giving me different documents and information related to my thesis.

Finally, to my family, my greatest support group, I am so thankful for the love you have given me. I cannot express in words my gratitude.

ABSTRACT

Broiler meat processing farms are generally recognized as one of the main factor of economic growth for the development of one country. These farms contribute to job opportunities, food safety, directly or indirectly protects environment and it creates a major window of opportunity for most developing countries. Ethiopia is one of the few African countries with a significantly large population of chicken, estimated at 56.87 million and poultry production is widespread and almost every rural family owns chicken.

Currently, with the rapid development of the country, people who live in cities use processed broiler meat. However, there is a shortfall of 56.7% of the demand in Addis Ababa. One of the reasons for the uncovered demand is that, there are few large scale poultry farms. Moreover these farms cannot produce to their full capacity because of not knowing how to use their resources effectively, information gap, poor inventory management system and knowledge gap. These means the farms have inefficient working system on the key drivers of internal supply chain.

This study covers how to improve internal supply chain of large scale poultry farms via production modeling to increase productivity. With this objective, in order to propose a model for broiler meat processing farms, the study analyzed the problems being faced by this sector. The study is done based on intensive interviews, questionnaires, focused group discussion and secondary data. According to the collected data most of the farms produce less than 50% of their capacity, do not have effective flock projection or planning method, have poor inventory management system, are disintegrated and unorganized, almost all farms use un modernized farming system.

So, to improve internal supply chain the study developed an excel flock projection data base and simulation model which allow for analysis of the processes and calculations of effective use of each resource, easily determine and quantify the required facility, enable communication horizontally and vertically throughout the internal supply chain.

TABLE OF CONTENTS

ACKNOWLEDGEMENT	I
ABSTRACT	II
TABLE OF CONTENTS	III
LIST OF TABLES	VII
LIST OF FIGURES	IX
LIST OF ABBREVIATIONS	X
CHAPTER ONE	1
1.1 INTRODUCTION.....	1
1.2 STATEMENT OF THE PROBLEM.....	2
1.3 OBJECTIVE OF THE STUDY	3
1.4 METHODOLOGY OF THE STUDY	3
1.4.1 Literature Survey	3
1.4.2 Method of data collection and source of data	3
1.4.3 Method of data analysis	4
1.4.3.1 Model development system	4
1.4.4 Conclusion and Recommendation	5
1.5 SCOPE OF THE STUDY.....	5
1.6 ORGANIZATION OF THE STUDY.....	5
CHAPTER TWO	7
2. LITERATURE	7
2.1 INTRODUCTION.....	7
2.2 SUPPLY CHAIN AND SUPPLY CHAIN MANAGEMENT.....	7
2.2.1 Definition and development.....	7
2.2.2 Supply Chain Drivers.....	9
2.2.3 Supply chain integration	10
2.2.3.1 Internal supply chain.....	11

2.2.3.2 External supply chain.....	11
2.2.3.3 Linkage between internal and external supply chain	12
2.3 INTERNAL SUPPLY CHAIN	13
2.3.1 Structure of internal supply chain	13
2.3.2 Benefits of internal supply chain	13
2.3.3 Integrating internal supply chain	14
2.3.4 Measurements of internal supply chain	15
2.3.5 Internal logistics.....	16
2.4 SUPPLY CHAIN MANAGEMENT MODELING AND OPTIMIZATION APPROACHES	16
2.4.1 Modeling approaches in SCM	17
2.4.1.1 Supply Chain Network Design Method:.....	17
2.4.1.2 MIP Optimization Modeling:.....	17
2.4.1.3 Stochastic Programming and Robust Optimization Methods:.....	18
2.4.1.4 Heuristic Methods:.....	18
2.4.1.5 Simulation based Methods:.....	18
2.4.2 Modeling approaches for internal supply chain.....	18
2.4.2.1 Network design in internal supply chain	18
2.4.2.2 Inputs required for supply chain modeling	20
2.4.2.3 Different models used to optimize internal supply chain network	21
2.4.2.4 Models developed to optimize internal supply chain of large scale poultry industries	23
2.5 SYSTEMS THINKING AND MODEL SELECTION	27
CHAPTER THREE	30
3. POULTRY PRODUCTION IN EHIIOPIA.....	30
3.1 INTRODUCTION.....	30
3.2 POULTRY FARMS OVERVIEW	30
3.2.1 Standard classification of poultry farms	31
3.3 Large scale poultry farms internal supply chain and its process	32
3.3.1 Overall process of broilers production in a farm	32
3.3.2 Broiler meat as food in Ethiopia compare to other countries	35

CHAPTER FOUR	36
4. DATA PRESENTATION, ANALYSIS AND MODELING	36
4.1 DATA COLLECTION.....	36
4.1.1 Survey Results	37
4.1.2 Survey through interviews and secondary data	43
4.2 SUMMARY OF FINDINGS	46
4.3 PROBLEM CONSEQUENCE	49
4.4 OVERCOMING THE PROBLEM	49
4.4.1 Components to improve internal supply chain	51
4.4.1.1 Input supply identification and selection	51
4.4.1.2 Facilities identification and selection.....	53
4.4.1.3 Information flow	56
4.4.1.4 Inventory management system	57
4.5 DEVELOPING A FLOCK PROJECTION ANALYSIS DATABASE SYSTEM AND A MODEL	58
4.5.1 Broilers placement schedule	58
4.5.2 Optimizing internal supply chain via production modeling	64
4.5.2.1 Model building process.....	64
4.5.2.2 Findings and input Analysis.....	65
4.5.2.3 Computer Model	66
4.5.2.4 Model Translation.....	67
4.6 SIMULATION RESULT	75
4.7 MODEL VERIFICATION AND VALIDATION	76
4.7.1 Model verification.....	76
4.7.2 Model validation	77
4.8 INTERNAL SUPPLY CHAIN IMPROVEMENT VIA PRODUCTION MODELING	78
CHAPTER FIVE	80
CONCLUSION AND RECOMMENDATION	80
5.1 CONCLUSION	80
5.2 RECOMMENDATION	81

REFERENCE.....	82
ANNEX -I	85
ANNEX -II.....	88
ANNEX -III	90

LIST OF TABLES

Table 2.1 Data Requirement For Supply Chain Model	21
Table 2.2 Comparison Between Des And Sd.....	29
Table 4.1 Education Background.....	37
Table 4.2 Year Of Establishment.....	38
Table 4.3 Year Of Experience	38
Table 4.4 Production Capacity.....	39
Table 4.5 Doc Purchase	39
Table 4.6 Doc Importing Interval	40
Table 4.7 Production Time	40
Table 4.8 Flock Projection.....	41
Table 4.9 Flock Projection Implementation.....	42
Table 4.10 Types Of Facility	42
Table 4.11 Information Flow Throughout Internal Supply Chain.....	43
Table 4.12 Linkage Between Support Institution	43
Table 4.13 Training.....	43
Table 4.14 Ethiopia Meat Consumption Projection To 2020	44
Table 4.15 2014/15 Broiler Meat Production In Ethiopia	45
Table 4.16 Imported Broilers Meat In Ethiopia.....	45
Table 4.17 Broiler Starter & Finisher Diet	52
Table 4.18 Acceptable Flock Density.....	54
Table 4.19 Broilers Rearing House Feeders And Drinkers Quantity	55
Table 4.20 Broilers Laying House Feeders And Drinkers Quantity.....	55

Table 4.21 Broilers Grow Out Feeders And Drinkers Quantity 55

Table 4.22 Houses Capacities And Capabilities 66

Table 4.23 Processing Times 66

Table 4.24 Model Validation 77

LIST OF FIGURES

Figure 2.1 Structure Of Internal Supply Chain.....	13
Figure 2.2 Supply Chain Network Design & Optimization Models.....	19
Figure 3.1 Broilers Meat Production Flow Chart	33
Figure 3.2 Typical Block Flow For A Broiler Meat Abattoir Or Slaughtering Plant.....	34
Figure 4.1 Fish Bone Diagram Analysis.....	46
Figure 4.2 Information Flow Throughout The Internal Supply Chain	57
Figure 4.3 Broiler Parent Rearing House Placement	59
Figure 4.4 Broiler Parent Laying House Placement	60
Figure 4.5 Hatchery Production.....	61
Figure 4.6 Broilers Grow Out Placement	62
Figure 4.7 processflowmap.....	64
Figure 4.8 Simulation Model For Doc Receiving And Broiler Parents Rearing	68
Figure 4.9 Simulation Model For Broiler Parents Laying	70
Figure 4.10 Simulation Model For Broiler Hatchery	72
Figure 4.11 Simulation Model For Broiler Grow Out And Slaughtering Section.....	74
Figure 4.12 Process Detail Summary Of Simulation Result.....	75

LIST OF ABBREVIATIONS

USAID – United States Agency International Development

FAO – Food and agriculture organization

SCM – Supply chain management

SC – Supply chain

IT – Information technology

FSC – Forward supply chain

RL – Reverse logistic

DOC – Day old chicks

ERP – Enterprise resource planning

MIP – Mixed integer programming

IEM – Integrated enterprise modeling

CSA – Central Statistical Agency

UN- United Nations

NGO - Non- Governmental Organizations

USD – United States dollar

BPR – Broiler parents rearing

BPL – Broiler parents laying

BG – Broilers grow out

DES – Discrete event simulation

SD – System dynamics

CHAPTER ONE

1.1 Introduction

Different researches are published about Ethiopian poultry sectors but almost all researches are done before 2010. From those researches there are some assessments on poultry supply chain and most of the researches are analyzing small scale and traditional poultry market supply chain management. In 2010 USAID published value chain analysis of poultry in Ethiopia and this research focused on both small scale and large scale poultry sectors and the study clearly shows poultry supply chain problems and the research concludes with this poor supply chain managing system plants do not involve investments beyond the cost of the foundation stock.

In the earliest days even if there is high population of poultry in Ethiopia the consumption of processed poultry meat in Ethiopia is uncommon for most Ethiopian consumers. But nowadays, there is a growing tendency in major urban towns, and consumer demand for processed poultry meat has increased. According to USAID published value chain analysis of poultry in Ethiopia the expected proportional contribution of poultry to the total animal protein production of the world by the year 2020 is believed to increase to 40%, the major increase being in the developing world. Ethiopia is one of the few African countries with a significantly large population of chicken, estimated at 56.87 million, (2014/2015, central statistical agency) [1]. Different researches states the total demand in 2014 in Addis Ababa is 8,000 tons of broiler meat but the supply at that year was 3,500 tons of broilers meat. So the unsatisfied demand for broiler meat in the city is estimated at 4,500 tons [2]. In Ethiopia, chicken are widespread and almost every rural family owns chicken. In nowadays with high economic growth in Ethiopia peoples want a processed broiler meat than live one, so to satisfy demand responsible parties and investors must turn their face to a large scale poultry processing plant investment.

According to different researches there are few large scale poultry processing farms in Ethiopia. And from these few large scale poultry farms only three of them are allocated in sector 1 according to FAO's classification. This shows the sector needs more focus because if it is handled in a proper way it has a big impact on the economic development of the country. Expanding and building a new farm is one way of solving the shortage but parallel to this the

farm must use its resources in an optimized way. So this research will focused on how to improve the internal supply chain of the poultry farm and tries to improve its supply chain via production modeling.

1.2 Statement of the problem

With fast economic and population growth in the country, the demand for poultry products has significantly increased. As per to different researches in 2014 there is a supply shortfall of 4,500 tons of broiler meat (56.7%) in Addis Ababa only. The demand or supply gap is expected to get wider in the coming years owing to the current (2.9%) annual population growth [3]. And the urbanization rate of 4% estimated for the country.

Ethiopia is one of African countries who have large chicken population; in the contrary, the country has few large scale poultry farms. But this year master plan of the country is to use the potential contribution of the poultry industry to improve food security, meat consumption and nutrition, and plan to increase the production by 235% in 2020 [34].

As per different studies, collected questionnaires and observations made, large scale poultry farms in Ethiopia have: low productivity, input materials schedule gap, lack of proper plant location, unplanned flock projection, lack of coordination and governance, limited information and poor technical knowhow. Generally, the main challenge for this sector is that producers lack how to use their resources effectively, information gap, poor inventory management system and knowledge gap. And these problems are one of the major key drives to evaluate performance of internal supply chain. This shows most of large scale broiler farms in the country have poor internal supply chain. To produce cost effective quality product, to become competitive and play major role in the development process of the country there must be a strong supply chain throughout the whole process. It is required that each party in the supply chain must work on their internal supply chain.

To solve this and other related problems this study focused to analyze internal supply chain of large scale poultry farms via production modeling.

1.3 Objective of the study

General objective

The general objective of the research is improving productivity of large scale poultry farms through internal supply chain via production modeling.

Specific Objective

- Setting process and methods to match the available resources or optimizing resource to increase productivity.
- Prepare a flock projection database
- Quantitatively analyze the production system, its capacity utilization and bottle neck.
- Propose a model that will potentially increase production capacity of poultry farms.

1.4 Methodology of the study

The following methodology is used to develop this study:

1.4.1 Literature Survey

The main sources of information especially for organizing the theoretical backgrounds are research books, different reliable books, different websites, previous related research studies and existing statistical data of the companies, etc.

1.4.2 Method of data collection and source of data

Both primary and secondary data is used in this study. A combination of different techniques is applied to collect the data required to analyze the problem. Data collection focused on the following areas:

Primary data collection: - to collect required data for the study the writer use different methods and these are

- Visual observation of large scale poultry farms and mainly focused on production , facilities used, method of production, method of communication etc
- Face to face Interviews with the employees (Directors, managers and employees)of the farms, poultry association members, consultants who have deep knowledge about poultry, different poultry breed, equipment and machineries suppliers
- Telephone interview – to collect general information about Ethiopian poultry sector data is collected through the phone.
- Questioner – Other than the writer observation the study also considers the opinion of managers and employees working in this area.

Secondary data collection – data which cannot be collected directly by the writer are collected from different researches, books, websites, research centers etc. and this data are scrutinized to ensure that the project had high validity and reliability, such as:

1.4.3 Method of data analysis

After primary and secondary data are collected, tries to identify the specific problems which affect the internal supply chain of the system and develop summary of findings.

To overcome these problems the study suggests theoretical solutions, develops a data base system which clearly shows the broilers placement schedule and simulation model.

1.4.3.1 Model development system

Simulation models are so data dependent such that the information collected has to be accurate so as to actually create reliable outputs which resemble the real system. The method the writer followed to develop the model is

- Identifying the configuration to design the model
- Identify and Collect Data - need to identify what data is necessary. These data requirements are commonly driven by the process map, process objectives and model inputs/outputs mainly system reliability, product arrival rate, processing time and resources etc.

- Build the Model - To build the model the study chosen discrete event simulation and software is ARENA version 14.00 created by Rockwell Automation Inc.
- Verification and Validation

Verification - After developing the model the study verify or ensured that the model behavior makes sense; entities are moving in the direction they should and process steps are taking place as expected

Validation - to check whether the simulation model outputs are close enough to the real system outputs or not, so the writer uses the excel database system to compare with. Because this model is developed on an existing system, which means it can be validated against historical data. In this situation the model input may use distribution based on the input data and then the output from the simulation run is compared against the actual historical results.

1.4.4 Conclusion and Recommendation

The project analysis is accompanied by some conclusions and recommendations for implementations, future actions that need to be accomplished by different sectors.

1.5 Scope of the Study

The scope of the study is identifying major problems of internal supply chain throughout the poultry processing farm up to improving the farm internal supply chain via production modeling specifically for broiler meat sector. And this research only focused on large scale poultry producing farms in Ethiopia.

1.6 Organization of the study

The study has five major chapters; the first chapter included the problem and its approaches, the second chapter discussed on related literature reviews on supply chain and supply chain management, internal supply chain and supply chain management modeling and optimization approaches. Overview of poultry industry in Ethiopia is covered in third chapter. The collected data from primary and secondary sources will be analyzed and core problems of supply chain will be identified through simulation in the fourth chapter. This chapter also includes detail

discussion and according to production modeling result improving the internal supply chain of any large scale poultry farm. The last part includes conclusions, recommendations, references used and annexes.

CHAPTER TWO

2. Literature

2.1 Introduction

A supply chain is basically a group of independent organizations connected together through the products and services that they separately and/or jointly add value on in order to deliver them to the end customer. It is very much an extended concept of an organization which adds value to its products or services delivers to its customers. From 1960 onwards, the active participation in supply chain and its appropriate management is the basic principle structure of any activity especially in the field of business. Generally, supply chain components, consist raw material preparation stage to the final delivery to the consumer [4].

2.2 Supply chain and supply chain management

2.2.1 Definition and development

This definition derives from the point of view of Raphael Kaplinsky and Mike Morris, who considered value chain as “the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producers services), delivery to final consumers and final disposal after use” [5].

In the 1980s, the term supply chain management (SCM) was developed to express the need to integrate the key business processes, from end user through original suppliers [6].

A supply chain is a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities involve the transformation of natural resources, raw materials, and components into a finished product that is delivered to the end customer. In sophisticated supply chain systems, used products may re-enter the supply chain at any point where residual value is recyclable [7].

Supply chain, commodity chain, production chain in other terminology, is defined as a range of activities conducted by individual or organizational stakeholders of the same chain to provide

product or service from the very beginning conception to the end users. These stakeholders normally include input providers, producers, processors, collectors, traders, wholesalers, retailers, consumers as well as third parties providing such additional services as finance, market research and logistic to these stakeholders. These participants of the supply chain have close vertical and horizontal linkages with each other

1. for the final purpose of ensuring efficient product flow to meet the demand of their target clients,
2. developing the supply chain,
3. creating a fair competitiveness in the supply chain,
4. optimizing productivity,
5. better the position of the products and supply chain stakeholders in the market, and
6. Maximizing profit.

The activities of these actors within a supply chain are classified into different stages, for example production, processing, distribution, etc. in which at each stage a new value is added to the supply chain.

Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies. Supply Chain Management is an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model. It includes all of the logistics management activities noted above, as well as manufacturing operations, and it drives coordination of processes and activities with and across marketing, sales, product design, finance and information technology.

The primary objective of SCM is to fulfill customer demands through the most efficient use of resources, including distribution capacity, inventory, and labor. In theory, a supply chain seeks to match demand with supply and do so with the minimal inventory. Various aspects of optimizing the supply chain include liaising with suppliers to eliminate bottlenecks; sourcing strategically to

strike a balance between lowest material cost and transportation, implementing just-in-time techniques to optimize manufacturing flow; maintaining the right mix and location of factories and warehouses to serve customer markets; and using location allocation, vehicle routing analysis, dynamic programming, and traditional logistics optimization to maximize the efficiency of distribution.

SCM is concerned with the Efficient Integration of suppliers, factories, warehouses and stores so that product is produced and distributed: In the right quantities, to the right locations and at the right time to in order to minimize total system cost and maximize customer satisfaction [8].

2.2.2 Supply Chain Drivers

The four drivers for supply chain performance are: Facilities, inventory, transportation and information.

1. Facilities: these are the places in the supply chain network where product is stored, assembled, or fabricated.
 - The two major types of facilities are production sites and storage sites.
 - Decisions regarding location, capacity, and flexibility of facilities have significant impact on the supply chain's performance.
2. Inventory: includes all raw materials, work in process, and finished good within a supply chain. It is an important supply chain driver because changing inventory policies can dramatically alter the supply chain's efficiency and responsiveness.
3. Transportation: entails moving inventory from point to point in the supply chain. Transportation is defined as: Movement of freight and passengers from one place to another. Transportation is the means of conveyance or travel from one place to another. The important common element in any definition of transportation is movement. Movement is changing of physical location of freight, passenger or exchange of
 - Take the form of many combinations of modes and routes.
 - Each has its own performance characteristics.

- The choices of transportation have a large impact on supply chain responsiveness and efficiency.
4. Information: consists of data and analysis concerning facilities, inventory, transportation, and customers throughout the SC. The role of IT in a Supply Chain is the driver that serves as the “glue” to create a coordinated supply chain. Information in a supply chain must be accurate, accessible in a timely manner and of the right kind so that it helps for supply chain management decisions on inventory, transportation and facilitating different facilities. All in all
- Information is potentially the biggest driver of performance in the SC as it directly affects each of the other drivers.
 - Also information presents management with the opportunity to make supply chain more responsive and efficient.

2.2.3 Supply chain integration

Supply chain integration which is considered as the cornerstone of supply chain management usually includes various functions within and across the company’s boundary. Supply chain integration has been around as early as 1989, Graham C. Steven who was a senior managing consultants as Peat Marwick Mc Lintock in London. According to him there are 4 stages supply chain integration framework and these are

1. Baseline: each department in the same company manages supply chain issues separately
2. Functional integration: each department in the same company works together to reduce costs
3. Internal integration:- each department is now connected via the same IT infrastructure to increase the efficiency
4. External integration: each company in the same supply chain join hand and work together

From Steven 4 stages of supply chain integration the first two integration can be included in the internal integration because without the two combination we can’t get internal integration so mainly there are two types of supply chain integration and these are internal and external.

2.2.3.1 Internal supply chain

Internal supply chain refers to the chain of activities or functions within a company that concludes with providing a product to the customer. Integration of these functions involves holistic performance of activities across departmental boundaries. A well integrated internal supply chain should result in excellent customer service and company performance [10].

Internal supply chain risks

Internal risks provide better opportunities for mitigation because they are within your business's control. There are 5 main types of internal risks:

- manufacturing risks - caused by disruptions of internal operations or processes
- business risks - caused by changes in key personnel, management, reporting structures or business processes, such as the way purchasers communicate to suppliers and customers
- planning and control risks - caused by inadequate assessment and planning, which amount to ineffective management
- mitigation and contingency risks - caused by not putting contingencies (or alternative solutions) in place in case something goes wrong
- Cultural risks - caused by a business's cultural tendency to hide or delay negative information. Such businesses are generally slower to react when impacted by unexpected events.

2.2.3.2 External supply chain

External supply chain can be divided into three basic types according to the partner along the material flow, which are supplier integration, distributor integration and customer integration [11].

External supply chain risks

External risks can be driven by events either upstream or downstream in the supply chain. There are 5 main types of external risks:

- demand risks - caused by unpredictable or misunderstood customer or end-customer demand
- supply risks - caused by any interruptions to the flow of product, whether raw material or parts, within your supply chain
- environmental risks - from outside the supply chain; usually related to economic, social, governmental, and climate factors, including the threat of terrorism
- business risks - caused by factors such as a supplier's financial or management stability, or purchase and sale of supplier companies
- physical plant risks - caused by the condition of a supplier's physical facility and regulatory compliance.

To improve both internal and external supply chain most articles suggest

1. It's not just technology project: supply chain integration is not just about linking different ERP system together. The concept is more profound and requires the right mindset.
2. Segment customers and anticipate changing needs: giving attention to the final customer
3. Relocate work:
4. No activity should be done more than once
5. The entire process should be managed in one database:
6. Trading partners should agree on the same metrics
7. Encouraging face to face contact

2.2.3.3 Linkage between internal and external supply chain

Both Rashton et al and Simchi-Levi advocate the integration evolution as going from functional to internal to external integration. Some of those advocating a relationship between internal and external integration are Chen et al who conclude that with true supply chain integration there is both upstream and (supplier) and downstream (distributor) player and “ internal integration provides the foundation of both.” Chen et al state that one of these integrations can happen before the other or focus can lie on either one: As such, there is no relationship or dependence on one or the other [12].

Koufteros et al have a different view stating that internal integration can have an effect on external integration and vice versa. One can facilitate the other as knowledge about processes is accumulated within the firm. Never the less, in their study they found indications that “internal integration is an important enabler of external integration, that is customer and supplier integration” Koufteros et al conclude that “internal integration means an internal system which facilitates external integration” [12].

2.3 Internal supply chain

Internal supply chain refers to the chain of activities within a company that concludes with providing a product to the customer. This process involves multiple functions within companies – purchasing, production, and distribution. It is obvious that these functions need to be integrated in order to provide good customer service. Internal integration contributes to cost reductions, the reduction of stock outs and lead time, as well as competitive advantage.

2.3.1 Structure of internal supply chain

In a systemic approach, internal supply chain can also be considered as a network of systems, sub-systems, operations, activities, and their relationships, where the members of the chain are: purchases, transporters, manufacturing section, distribution centers. In other words Internal supply chain performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers.

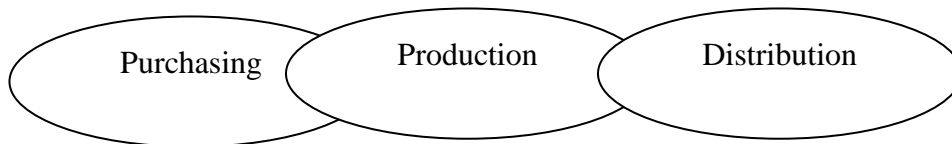


Figure 2.1 Structure of internal supply chain

2.3.2 Benefits of internal supply chain

The advantage for individual supply chain members is that through coordination of their value-creating activities, the entities involved create more value together than they would have working

independently. In working as a united entity, the benefits and risks are shared among participants enforcing “internal mechanisms” and the development of “chain wide incentives for ensuring timely production and delivery” [12].

Thompson and his colleagues have identified five areas in which internal supply chain management can have a direct effect on corporate value. They include:

- Profitable growth. Supply chain management contributes to profitable growth by allowing assembly of "perfect orders," supporting after-sales service, and getting involved in new product development. Potential analysis · Concept study · Detailed planning · Project or change management The main feature of Miebachs integrated approach is the simultaneous consideration of strategy, engineering and IT at every step to arrive at an optimum Supply Chain Management solution, the problem".
- Working-capital reductions. Increasing inventory turns, managing receivables and payables, minimizing days of supply in inventory, and accelerating the cash-to-cash cycle all are affected by supply chain execution.
- Fixed-capital efficiency. This refers to network optimization--for instance, assuring that the company has the right number of warehouses in the right places, or outsourcing functions where it makes more economic sense.
- Global tax minimization.
- Cost minimization. This largely focuses on day-to-day operations, but it also may involve making strategic choices about such issues as outsourcing and process design.

2.3.3 Integrating internal supply chain

Internal supply chain integration is perceived both as the extent to which an organization manages its inter-organizational processes to achieve effective and efficient flows of products, services, information, money and decisions with the objective of providing maximum value to its customers (Bowersox et al., 2002, Frohlich & Westbrook, 2001; Naylor et al., 1999), and as the endeavor of removing barriers that impede the realization of the utopian, fully integrated, seamless supply chain (e.g. Childerhouse et al. 2011). There are four Barriers of internal supply chain and these are Culture, Technology, Finance and organization. So one can say the company has a strong integrated supply chain by defeating those four barriers [13].

A more complex approach to supply chain management requires a more flexible and professional approach of managers and entrepreneurs to process structuring, process management and operations. Each supply chain function requires new abilities:

1. Demand planning also requires shared information and systems to work with shared information.
2. Ordering in the stores is aided by the computer and point-of-sale data, but this requires educated employees who act like stock controllers
3. Order execution delivers improved lead times and fill rates, but requires the development of responsive and reliable fulfillment processes
4. Capacity planning in integrated supply chains lead to improved capacity usage, but requires more flexible manufacturing and logistics
5. Materials planning will have to align supply and demand by utilizing demand information for materials planning
6. Purchasing will no longer aim for lowest prices, but this function will have to be able to reduce total transaction costs by cost/profit management. This is not easy, but proves to be very rewarding.

These requirements are still expressed in a very general way. Each company that takes internal supply chain integration seriously will have to develop a practical plan to develop these new abilities. Often the implementation of new systems will guide existing workers into the new direction. It is however very clear that there often is a need to hire experienced workers and replace the existing employees. Also the introduction of integrated supply chains often means the participation of financial experts to guide trading partners that work together in projects to optimize the entire supply chain by investing in one company and getting the benefits in another company (mostly the customer) [14].

2.3.4 Measurements of internal supply chain

In order to reflect the operations of the supply chain, there should be set up with suitable methods of supply chain performance measurement and to determine the appropriate target system for performance measurement. Measurement of supply chain performance indicators not only reflect the operating performance of the enterprise, but also evaluate the overall operation of

the supply chain performance levels. In actual operation, in order to set up an effective supply chain performance measurement target system, the following principles to be followed: [15]

1. Analysis focus on key performance indicators
2. Should use the target system performance which reflect the supply chain business process
3. Measurement indication should be able to reflect the operation of the whole supply chain, rather than just reflect a single node in the operations of enterprises
4. Should maximize the use of real-time analysis and evaluation methods, performance metrics
5. Should be extended to reflect the supply-chain information in real –time operation, because this analysis is more valuable than after the work
6. When measure the performance of the supply chain, it is necessary to use the measurement indication, which reflect the relationship of suppliers, manufacturers and users, extend the measurement objects up to relevant enterprise in supply chain

2.3.5 Internal logistics

Internal logistics is one of the most important sections within enterprises, especially in the large manufacturing companies. It manages, arranges, plans and delivers the finished products. It is an indispensable part of the supply chain, as well as reflects the result of implementation company strategy [15]. The main objective of logistics management is having quick response, small variation, low inventory, transport integration, quality of product.

2.4 Supply chain management modeling and optimization approaches

In today's global market, managing the entire supply chain becomes a key factor for the successful business. World-class organizations now realize that non-integrated manufacturing processes, non-integrated distribution processes and poor relationships with suppliers and customers are inadequate for their success. In the early 1990s, the phrase “supply chain management” came into use. Supply chain management is a process of integrating/utilizing suppliers, manufacturers, warehouses, and retailers, so that goods are produced and delivered at the right quantities, and at the right time, while minimizing costs as well as satisfying customer requirements.

Most of simulation tools are designed as interactive tools to be used by a human planner not as real time decision-making tools, which are directly linked to control system to dispatch tasks. Simulation tools aid human planner to make a right decision by providing information. However, human planner should be able to interpret and modify the plan in order to achieve better supply chain performances. Benefits of supply chain simulation are as follows:

- It helps to understand the overall supply chain processes and characteristics by graphics/animation.
- Able to capture system dynamics: using probability distribution, user can model unexpected events in certain areas and understand the impact of these events on the supply chain.
- It could dramatically minimize the risk of changes in planning process: By what-if simulation, user can test various alternatives before changing plan.

2.4.1 Modeling approaches in SCM

Dong has categorized modeling approaches in SCM into five broad classes (Dong, 2001): and these are classified as follows [16].

2.4.1.1 Supply Chain Network Design Method:

This method determines the location of production, stocking, and sourcing facilities, and channels the products take through them. The earliest work in this area, although the term “supply chain” was not then in vogue, was by (Geoffrion et al., 1974). They introduced a multi-commodity, logistics network design model for optimizing finished product flows from plants, to the distribution centers to the final customers.

2.4.1.2 MIP Optimization Modeling:

Many important supply chain models fall into the MIP (Mixed- Integer Programming) class. This includes most models for vehicle routing and scheduling, facility location and sizing, shipment routing and scheduling, freight consolidation and transportation mode selection. Mixed-integer models are often difficult to optimize, as there can be an exponential number of possible decision alternatives. Some problems are nonlinear MIP. MIP can model complex planning and control problems involving both continuous and discrete decisions.

2.4.1.3 Stochastic Programming and Robust Optimization Methods:

Stochastic programming deals with a class of optimization models and algorithms in which some of the data may be subject to significant uncertainty. Uncertainty is usually characterized by a probability distribution on the parameters. Such models are appropriate when data evolve over time and decisions need to be made prior to observing the entire data stream.

2.4.1.4 Heuristic Methods:

Heuristic is another important class of methods for generating supply chain alternatives and decisions. A heuristic is simply an intelligent approach that attempts to find good or plausible solutions. Generally, mathematical programming methods are used to solve strategic and higher levels of tactical supply chain planning. This method generally works only for solving linear- and some integer-based models, commonly used in strategic levels of planning. Heuristic methods used in supply chain planning and scheduling include the general random search approaches such as simulated annealing, genetic algorithms and tabu algorithms. Recently, the theory of constraints has also been used in supply chain operational planning.

2.4.1.5 Simulation based Methods:

This is a method by which a comprehensive supply chain model can be analyzed by considering both its strategic and operational elements. This method can evaluate the effectiveness of a pre-specified policy before developing new ones.

2.4.2 Modeling approaches for internal supply chain

2.4.2.1 Network design in internal supply chain

The supply chain operation is majorly divided into four main functions namely sourcing, production, logistics and sales/customer service. It has been observed that the alignment regarding their individual (function specific) and company objectives are not very well defined which leads to inter functional conflict in objectives. Different functions working on their individual objectives lead to local optimization and not enjoy the benefits of global optimization. The cost associated to achieve certain level of service level becomes high when compared to optimization done in keeping end-to-end cost in picture [17].

Network Design & Optimization Models Overview:

Network Design is a process to determine the unique network configuration for the supply chain that offers the lowest total cost/ highest total profit considering operational and financial risk while achieving targeted Service Levels. Network design exercise involves many decision variables like location and capacity of facilities, product – location combination decisions, decisions on transportation lanes etc subject to real world constraints of capacity, manufacturing, sourcing and serviceability requirements. Thus supply chain network design provides answers to some of the key questions in supply chain network.

Questions answered by supply chain network design & optimization models

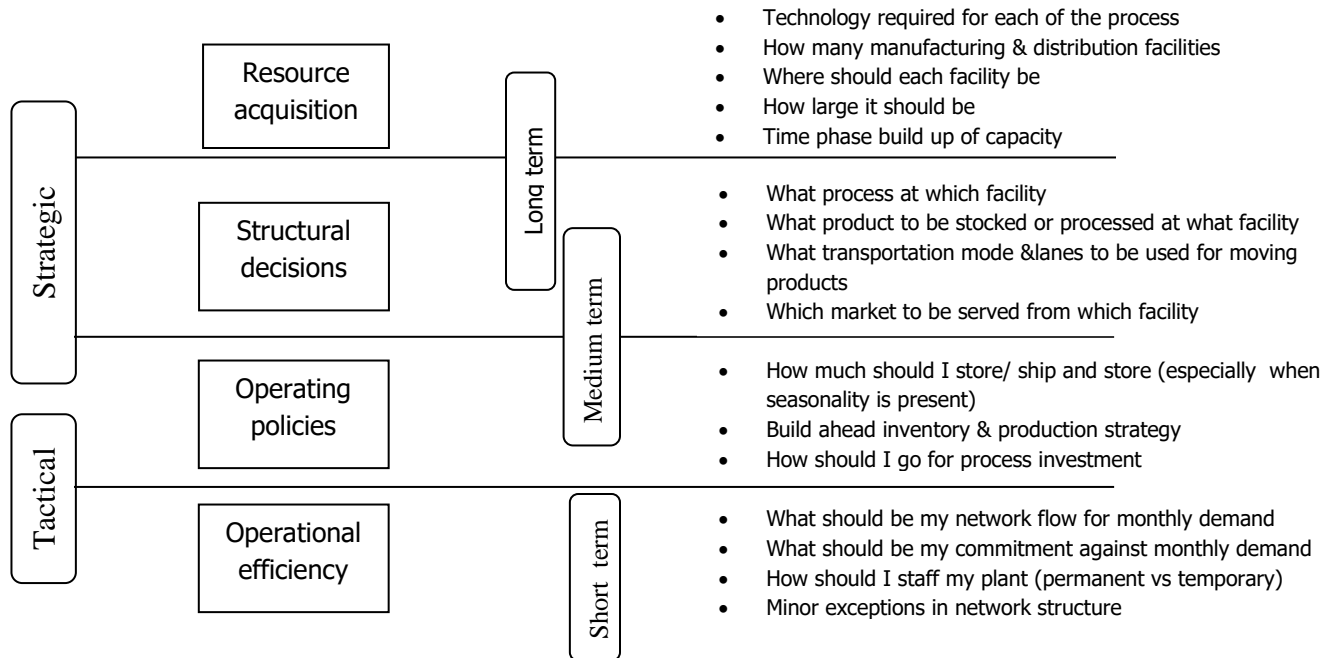


Figure 2.2 supply chain network design & optimization models

Supply Chain Network Optimization tools:

Supply chain network optimization tools provide end-to-end supply chain modeling which includes sourcing, manufacturing and distribution. These tools provide options to incorporate

large number of constraints with lots of decision variables. The best in class tools in this category are i2 Strategist, supply chain guru, IBM network optimization workbench etc

Key aspects include its ability to:

- Model the entire supply chain from raw materials to finished products to delivery
- Improve strategic and tactical decision making with visibility into network design, sourcing and capacity
- Plan for uncertainties with what-if scenario generation and analysis
- Understand and project the inventory costs of network design decisions based on stochastic parameters

2.4.2.2 Inputs required for supply chain modeling

In supply chain, decisions taken are usually classified as strategic, tactical, or operational. Strategic decisions are related to the company's strategy and are long term (2-5 years) with involvement of the most partners in the supply chain. Tactical decisions are midterm (a month to 1 year). Operational decisions are short term, which are related to the day-to-day activities. Tactical and operational decisions are taken in individual area of the supply chain (e.g. plant and warehouse). They deal with issues in demand, procurement, production, warehouse and distribution [18]. Selection of performance measures is depends on the organizational goal. Example performance measures can be found from. The writer suggest the following procedures for the simulation study of supply chain management: [19]

- Understanding supply chain processes (understanding the business process and industry characteristics) and planning processes
- Design scenario (Most of the time it is not reasonable to model every details of the supply chain. It is a good idea to focus on the problem areas)
- Data collection
- Performance measures
- Define target (what is near optimal) for each performance measure
- Define termination condition
- Evaluation of supply chain
- policies/strategies

Table 2.1 Data requirement for supply chain model

Area	Data required
Manufacturing process and time information	<ul style="list-style-type: none">• Manufacturing process data (process time, queue time, set up time, number of machine in each process, alternate route)• Calendar data (shift information, holiday, preventive maintenance information)• Machine data• Bill of material structure
Inventory control policies information	<ul style="list-style-type: none">• Safety stock level, reorder point• Inventory level of finished products, raw material and intermediate parts• Any stock location in shop floor
Procurement and logistics information	<ul style="list-style-type: none">• Supplier lead time• Supply lot size• Supplier capacity• Procurement horizon• Procurement time
Demand information	<ul style="list-style-type: none">• Due date• Priority• Start and end data• Demand pattern
Policies strategies information	<ul style="list-style-type: none">• Order control policies, dispatch policies

2.4.2.3 Different models used to optimize internal supply chain network

As stated above there are different models are used to optimize supply chain and from these different types, simulation has mostly been used to study supply chain behavior and performance since late 1980s. Recently, there emerge in the literature some works on food supply chain modeling using discrete-event or continuous simulations to study the global dynamics of the supply chain. The simulation approach was originally based on system dynamics. This was motivated by the fact that the structure of the SC and the flow control determine its performance. SC modeling and simulation were later investigated with discrete event simulation and

continuous simulation. Van de Vorst et. al, 2000 apply discrete-event simulation for modeling the dynamic behavior of food supply chains and evaluating alternative designs of the supply chain.

Simulation of SCM using a continuous simulation approach

Different types of flows (manpower, technology, money, and market) stocks or levels which are integrated over time according to flow variations System dynamics is centered on the dynamic behavior. It is a flow model where it is not possible to differentiate individual entities (like transport resources). Management control is performed by making variations on rates (production rates, sale rates). Control of rates can be viewed as a strong abstraction of common production management rules [20].

With the time bucket driven approach (sometimes called “spreadsheet simulation”):

- Time is divided in periods of a given length (time buckets)
- Time is incremented step by step within a given time bucket. At the end of each step a new state is calculated using the model equations. The implication is that events (corresponding to a change of state) occur at the beginning of each period
- the lead time for an item in a production resource is considered small compared to the size of the time bucket
- The main states are the states of the set of resources. They describe the activities in which resources are implicated in a given time period. They are characterized by the quantities of items processed in this activity in a given time period; e.g., the number of items of a given type manufactured, stocked or transported by a given resource in a given period
- The simulation processor has to determine all the states of all the resources at each period.

Simulation of supply chain management using the discrete event approach

In the discrete event approach, it is between a “time bucket driven approach” and an “event driven approach”. This differentiation is based on the time advance procedure which characterized these two approaches.

In an event driven discrete event model:

- the states are the states of the various items which typically reflect the resources used by these items and the time duration of this use
- the simulation processor must determine the times of all the events (i.e., state changes)
- state changes are characterized by appropriate logic conditions
- A time advance algorithm that suitably manages a future events list, is mandatory.

Application of Modeling and Simulation in SCM

The manner in which simulation is used in SCM depends very much on type of problem that needs to be solved. Furthermore the underlying model is likewise developed according the SCM function planned to evaluate. Two particular problem features that have an important impact on the nature of the final simulation model are: – the degree of systemic decomposition of the SCM system (decision system, information system, physical system)

Distribution level of the system (centralized or distributed) A centralized SCM system consists of a single information and decision system for all entities of the supply chain under study. On the other hand, in a distributed SCM system the decision system is distributed over the different entities of the supply chain. In fact, the execution of the simulation can likewise be performed in a centralized way on a single computer or in a decentralized way on a multiprocessor computing platform (parallel simulation) or on geographically distributed computers interconnected via a network, local or wide area (distributed simulation).

2.4.2.4 Models developed to optimize internal supply chain of large scale poultry industries

Developed models specifically for poultry industry supply chain is not that much but there are few and most of these researches focused on over all supply chain of poultry production. And there are no researches or studies done on optimizing productivity of poultry farms to improve internal supply chain. So this study only took the methodology they use as an input to develop the production model; some of the models developed in this area are indicated as follows:

System dynamic model - Mohammad Shamsuddoha, PhD Student, Curtin University developed a model on poultry supply chain and this article focused on how poultry supply chain networks can achieve stability/sustainability in terms of structured network to gain benefits, meeting demand and supply and achieving highest productivity. This quantitative study investigates these questions using a production process simulation model of a poultry parent stock farm and its forward and reverse chains.

The model was developed in a system dynamics simulation environment using a design science methodology. Model analysis shows that intricate poultry supply chains behave inconsistently over time to meet market demands. The paper also focuses on poultry unused wastages. The objective of the study is to find out social, economic and environmental benefits through forward and reverse poultry supply chains. Here the study use casual loop diagramming

Causal model building - Recently, it is an important part of a system dynamics model. Positive and negative feedback loops are the building blocks of system dynamics and causal diagram led to the conceptualized a prospective model (Richardson, 1986). A causal loop diagram also provided the visualization of how interrelated variables affect one another. The diagram consists of a set of nodes representing the variables connected together (Aghalaya, Elias, and Pati 2012, Maani and Cavana 2007). The relationships between variables, represented by arrows, can be labeled as positive or negative. To generate a directed arrow, a positive (+) sign near the head of the arrow indicates that an increase (or decrease) in a variable at the tail of an arrow caused a corresponding increase (or decrease) in a variable at the head of the arrow. If an increase in the causal variable caused a decrease in the affected variable, a negative (-) sign was placed near the head of the arrow (Aghalaya, Elias, and Pati, 2012). The model also consist number of reference variable and excels lookup to compare and contrast it with real life output [21].

The study use SD simulation to predict the next four additional years result /output based on historical business wave and this helps producers and policy makers to make policy.

SCOR Model and VSM model - Kowsar Darivandi Shoushtar, Hossein Ghasemi, Mansooreh Zarezadeh are who involve in this paper, which deals with diagnosing broiler meat supply chain and designing a new meta systemic (in cybernetic terms) structure for it in Iran. It deals with a combination of Beer's VSM and SCOR model are utilized for analyzing the situation.

Objective - SCOR (supply chain operations reference) is a process model and can be utilized as an aiding framework for process identification. However VSM (value stream mapping) is more general. It is not restricted to structures or processes and includes all functional aspects of the system. A combination of VSM and SCOR provides a rich framework for identifying the situation.

Analysis result - The paper basis is twofold. First it illustrates utilizing functionalist insightful methods in a complementary role alongside the viable system model. SCOR model and resource-based approach are used in this regard. Second the paper illustrates combining a functionalist and an interpretive method together which results in a rich organizational structure, because the role of metasystem for an organization is equivalent to the brain for an organism. The more connected and coherent more resemblance to brain [9].

Reference model by integrating different models - Markus Rabe, Frank-walter jaekel, Heiko weinaug paper explains techniques which support cross-enterprise design and configuration based on reference models. Thereby, different approaches such as SCOR, the integrated enterprise modeling (IEM) and a specific distributed simulation method are used and integrated into a consistent reference model approach. The main aim of this paper is to show concept for business process modeling based on a reference model which integrates various functions [23].

System dynamics model - Thile Hoa, Daniel Thiel, University of Nantes and e.n.i.t.i.a.a. Nantes, Lem- Largecia, were interested in studying the behavior of the entire chicken meat supply chain coping with sanitary crises effects. A model is proposed to study the SC behavior dealing with the shortages in upstream supply capacity and downstream unpredictable consumer behavior disturbed by the crisis as well. This model will be simulated and analyzed to investigate the behavior of the chicken meat SC under bird flu crisis during the period from October 2005 to March 2006 in France. Then the model uses a sensitivity analysis to study the supply chain stability under different environment uncertainties. The model became helpful to decision-makers for other fresh food supply chains when they are facing such crises. And the simulation of the system dynamics model has been carried out in the programmable continuous simulation environment of software that makes it possible to simulate internal dynamics of each SC stage and also the entire chicken supply chain in sanitary crises situation as well.

As the first step the study identifies the modeling approach is to define the key system features and to create a high-level causal loop diagram that captures the key elements of the system in question including the major feedback loops.

The feedback loop includes

- Actual expected demand gap
- Expected order rate
- Processing
- Distribution inventory
- Retail inventory

Based on the developed causal diagram, the mathematical formulation of stocks and flows structures by a set of nonlinear differential level and rate equations are defined. Base upon the causal loop diagram and the mathematical formulation of levels and flows diagram, the SD model of the chicken meat supply chain is modeled in iThink® software.

Finally the simulation results show that fluctuations in customer demand and production are progressively amplified by each supply chain stage and affect the stability of the whole chain [24].

Discrete event simulation – as stated above there are no researches which use DES to optimize poultry farm production. So to take as an input for this study the writer tries to see related studies. Out of many studies which are focus on production and service optimization by using discreet even simulation the following are assessed and presented below. Edwin s. Kim, Masters student, University of Massachusetts, the main aim of the study is to work on the bottle neck areas for ED and NED patients. And the DES helps to understanding the admission process would provide benefits to explaining how the system behaves and solve critical bottlenecks [36].

The second study on DES is by Livhuwani Mashavha, University Of Pretoria, The research use DES by using arena software to simulate and analysis the milk process. And the simulation gives an idea where the milk factory should focus to have a smooth flow [37].

The third assessed study by Carlos Rodriguez Monroy, Joaquín Fuentes-Pila and Wilfredo Guaita, Food Quality Engineering Research Group Technical University of Madrid and University of Guayana, Venezuela. This study tries to implement a coordinated supply chain and

to optimize the operational policies for reaching global goals; the study design the configuration of the supply chain by using different tools and software for the simulations of discrete events. After they configure supply chain design, then they use SD model to simulate different operational policies and selects the best one for a supply chain that is expected to be competitive for the efficient delivery of customers' orders [38].

2.5 Systems thinking and model selection

The writer tries to see different models developed similar to this specific case but as stated above there are no researches and studies done. So based on the above models SD and DES are popular used to simulate different process or crises in a poultry farm. The study use its objective to decide and choose proper model to this specific case and based on this the following analysis is done.

SCOR and VSM only focused on the structure of the supply chain and it is far from the objective of this study. And SCOR has limitations on product and process design and development processes, or some post-delivery technical support processes.

System dynamics

As per to the above two models which focused on poultry farms, system dynamics (SD) combines two distinct aspects; one qualitative and one quantitative, with the aim of enhancing the understanding of an identified problem and improving comprehension of the structure of the problem and the relationships present between relevant variables.

On the first study SD model analysis shows that intricate poultry supply chains behave inconsistently over time to meet market demands. And using the SD model they can predict the next four additional years result /output based on historical business wave and this helps producers and policy makers to make policy. The second research also shows the fluctuations in customer demand and production are progressively amplified by each supply chain stage and affect the stability of the whole chain. Generally SD models applications on the above studies gives a descriptive or judgmental data as well as numerical data. So the above analysis used to make policy rather than decisions.

Discrete event simulation

None of the above studies (on poultry sector) are done by using discrete event simulation. But there are studies on other sectors which use discrete event simulation. Different books theoretically put the following points about discrete event simulation. DES is arguably the most widely used operation research technique in practice. It is used to model systems that can be viewed as a queuing network. Individual objects (entities) pass through a series of activities, in between which they wait in queues. The rules governing the order in which these activities occur and the conditions for them to take place can be extremely complex. Each individual entity can be given characteristics that determine what happens to that individual in the system. The durations of the activities are usually sampled from probability distribution functions [35].

- DES models make frequent use of animation and graphics, and can be made interactive; all these features are very useful for communication with clients.
- The models produce a vast range of output, often showing the whole distribution of possible outcomes in addition to summary measures.
- DES models have traditionally been applied at a tactical, operational level. DES by definition stochastic in nature and deal with distinct entities, scheduled activities, queues and decision rules.
- DES models are simulated in unequal time steps (when “something happens”); the model is almost always simulated, and DES requires large amounts of quantitative, numerical data.
- It is easy to develop a rough working model very quickly, no knowledge of programming is required, and it facilitates communications with clients if the modeler can develop and run a demonstration model during a single meeting.

To summarize, SD models are mainly used at a strategic or conceptual level; they are basically deterministic, and they treat simulated objects as a continuous mass. The aim of an SD model is usually to gain an understanding of feedback dynamics and long-term system behavior. The models may not be simulated at all since the influence diagrams are often found to be the most useful part of the modeling process. SD does not attempt optimization or point prediction, but it is capable of modeling very large complex systems and can deliver a wealth of qualitative and

quantitative output measures. SD is less good at detailed resource allocation problems. Parameter estimation and validation are less of an issue with SD than with DES (but still difficult). Compared with DES, and with a few notable exceptions, SD models are not all that well-known in the academic community and are not widely used by practitioners [35]. And also as of as of David Lane [4] saying SD models are never more than 40% accurate.

Model gap analysis and model selection

According to the mentioned criteria on which the selection is made are summarized in Table 2.2 the following evaluation criteria are not value based but a simple mechanism used and decide which approach tackles the most important issues on optimizing the process.

Table 2.2 Comparison between DES and SD

Evaluation criteria	Discrete even simulation	SD simulation
Scope	Operational, tactical	Strategic
Importance of variability	High	Law
Importance of tracking entities	High	Law
Number of entities	Small	Large
Control	Holding queues	Rates (flows)
Relative timescale	Short	Long
Purpose	Decisions: optimization, prediction and comparison	Policy making: gaining understanding

As stated above the model selection is done based on the aim of the study, which is by enhancing productivity to improve internal supply chain of large scale poultry farms. This means to see the process throughout the supply chain, queuing network, individual objects (entities) pass through a series of activities, the output etc all in all to optimize the production process of the farm. So the study decides to use discrete event simulation for this specific case.

CHAPTER THREE

3. POULTRY PRODUCTION IN ETHIOPIA

3.1 Introduction

There are more than 20 private large scale commercial poultry production farms, all of which are located in and around Addis Ababa, particularly in and around Debre Zeit. ELFORA, Alema and Genesis are the top 3 largest commercial poultry farms with modern production and processing facilities. Out of these large scale poultry farms there are few which produce broiler meat and these are ELFORA Agro Industry, Alema, Almaze, ELERE and Tseday chicken farms. Established in 1997, ELFORA has large scale poultry farms at 4 different locations and sub-locations. ELFORA has modern broiler processing (slaughter houses) and packing units and produces broiler meat and day old chicks. The slaughtering service has a capacity of 1,000,000 kg/year. ELFORA annually delivers around 483,000 kg chickens to the markets in Addis Ababa [28]. Alema Farm is the second largest enterprise delivering nearly a quarter a million broilers to Addis Ababa market every year. It has its own parent stock from Holland, a feed processing plant, hatchery, slaughtering plant, cold storage and transport facility at its sites of operation.

There is also clear evidence that the price of meat will increase from both small ruminants and larger animals, making these items unaffordable for the majority of poor in Ethiopia. The only meat that can be affordable to the majority of poor will be poultry meat. Hence it is important for more productivity and commercialization to take place in the poultry sector [27].

3.2 Poultry farms overview

Poultry production has an important economic, social and cultural benefit and plays a significant role in family nutrition in the developing countries. Ethiopia has large population of chickens estimated about to be 56.87 Million [1] with native chickens of non descriptive breed representing 95.86% hybrid of chickens 2.79% and exotic breed of chickens mainly kept in urban and peri-urban areas 1.35% [3]. From the total population, cocks constitute 10.2%, cockerels 52%, pullets 9.8%, non laying chicken 3%, chicks 38.23%, and laying chicken 33.3% [29]. Village chicken production system in Ethiopia followed by primitive type with 5-20 birds per household simple rearing in backyard with inadequate feeding and health care. However;

the population number of chicken flock is small [25]. Such production system may result in slow growing and poor layer of egg.

The size and composition of flocks kept by households vary from year to year owing to various reasons such as mortality from diseases, agricultural activities and household income needs. Mortality in local birds results mainly from disease and predators as well. A research report indicated that 62% of small farmers reported disease as the major factor for high mortality while 11% noted predator as a major factor too.

The large-scale commercial production system is highly intensive production system involves an average of greater or equal to 10,000 birds kept under indoor conditions with a medium to high bio-security level. This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management systems. It is estimated that this sector accounts for nearly 2% of the national poultry population. This system is characterized by higher level of productivity where poultry production is entirely market oriented to meet the large poultry demand in major cities. The existence of somehow better bio security practices has reduced chick mortality rates to merely 5%.

3.2.1 Standard classification of poultry farms

Alternatively, the FAO classifies poultry production systems into four sectors, depending on the level of bio-security. Based on this system of classification, Ethiopia has three poultry production systems: large commercial poultry production with “moderate to high bio security” (sector 2), small commercial poultry production with “low to minimal” bio security (sector 3) and village or backyard production with “minimal bio security” (sector 4) (Nzietchung 2008). FAO’s classification of poultry production system is shown Annex II [27].

As per to FAO’s classification ELFORA Agro Industry and Alema are the only broiler farms which fits under sector 1 to the remaining poultry farms are classified under the remaining sectors [27]. The main commercial poultry farms – Elflora, Agro Industry and Alema – are located around Debre Zeit in Oromia. The sector 3 system is emerging around the urban and peri-urban areas of Ethiopia. In terms of the FAO definition, sector 4 or the village or backyard production represents the main poultry production system in most parts of the country.

Modern industries of poultry production is a highly intensive production system that involves, on average, greater or equal to 10,000 birds kept under indoor conditions with a medium to high bio-security level. This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management system. It is estimated that this sector accounts for nearly 0.8% of the national poultry population. This system is characterized by higher level of productivity where poultry production is entirely market-oriented to meet the large poultry demand in major cities. The existence of somehow better bio-security practices has reduced chick mortality rates to merely 5% (Bush, 2006). In Ethiopia, the commercial poultry sector is situated mostly in Debre Zeit areas. ELFORA and Alema farms are the major large-scale poultry enterprises in Ethiopia that are located in Debre Zeit. ELFORA, the largest enterprise, supplies about 483,000 kg chickens per annum to the urban markets in the capital (2014/2015). This supply accounts for close to 60% of the total poultry production from the commercial sector in the Debre Zeit areas.

3.3 Large scale poultry farms internal supply chain and its process

Internal supply chain parties of large scale poultry industries include raw materials supply, farm production, product processing and storing and distribution. To have an effective internal supply chain there must be integration between the above mentioned parties or departments. Different from vertical integration, this integration focuses on the seamless connection of firms to improve the whole supply chain competitiveness by establishing and maintaining a long-term strategic partnership based on information integration, function and business reengineering, organization. Poultry production is a profitable processing plant but it should be handled carefully and its internal supply chain must be smooth and strong [25].

3.3.1 Overall process of broilers production in a farm

Most of large scale poultry plants start operation by importing DOC from abroad because as stated above there are not companies which produce parent stock. So the process starts with importing DOC as soon as they arrive they are placed in broiler parents rearing house and they will be reared for 23 weeks. After 23 weeks this parents will be transferred to broiler parents laying house where they can lay eggs. Here they are staying for 42 weeks until then they lay eggs, then the parents will be culled. The eggs which are layed will be collected every day and

will be transferred to hatchery. Here to hatch an egg it takes 21 days after vaccinating each chicks they will be transferred to broilers grow out. In the grow out house chicks will grow for 5 weeks only by that time they will be 1.8kg (standard weight of live birds). Then these birds are transferred to slaughtering house then packed and transferred to cold storage or freezer. Theses process is presented as follows.

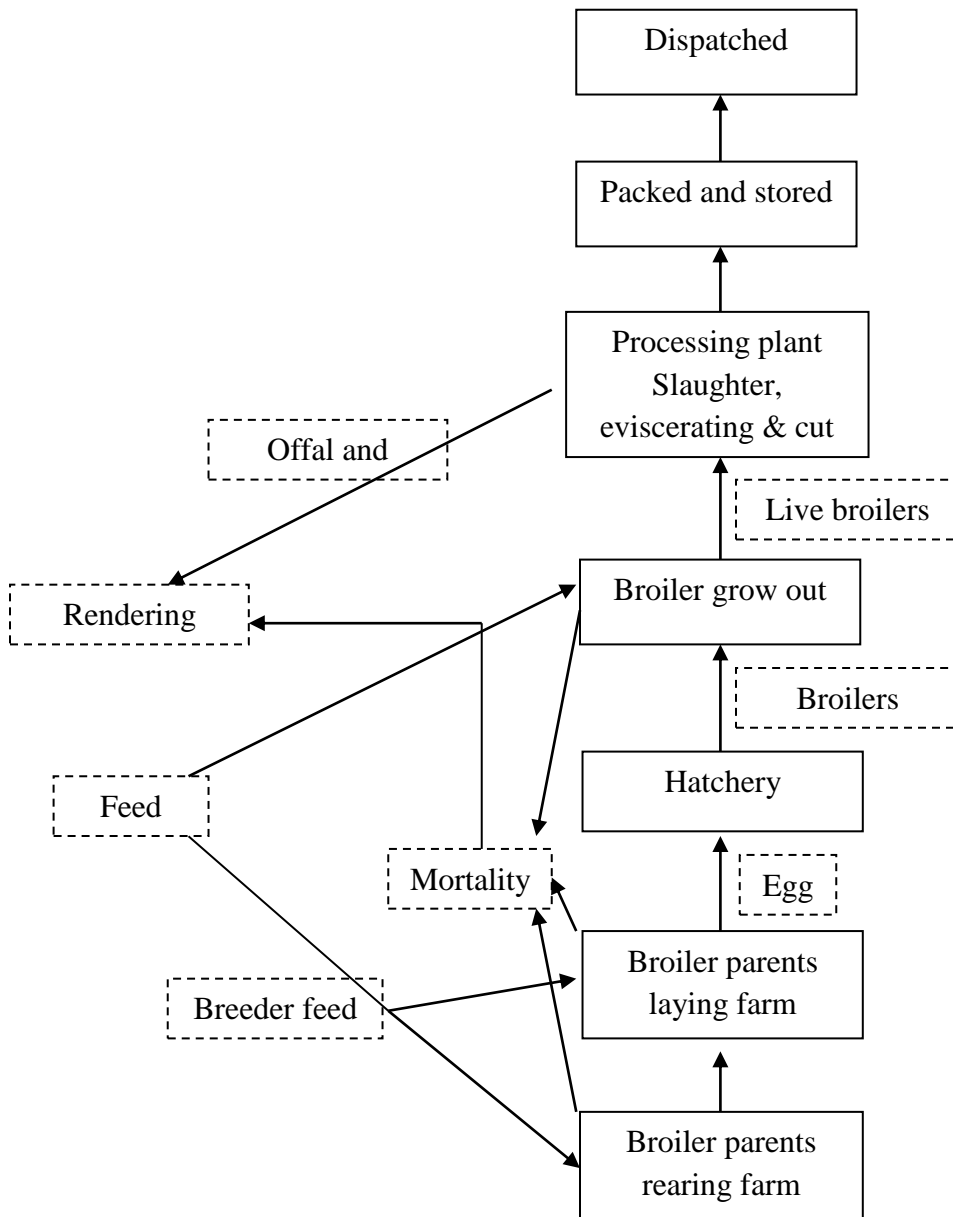


Figure 3.1 Broilers meat production flow chart

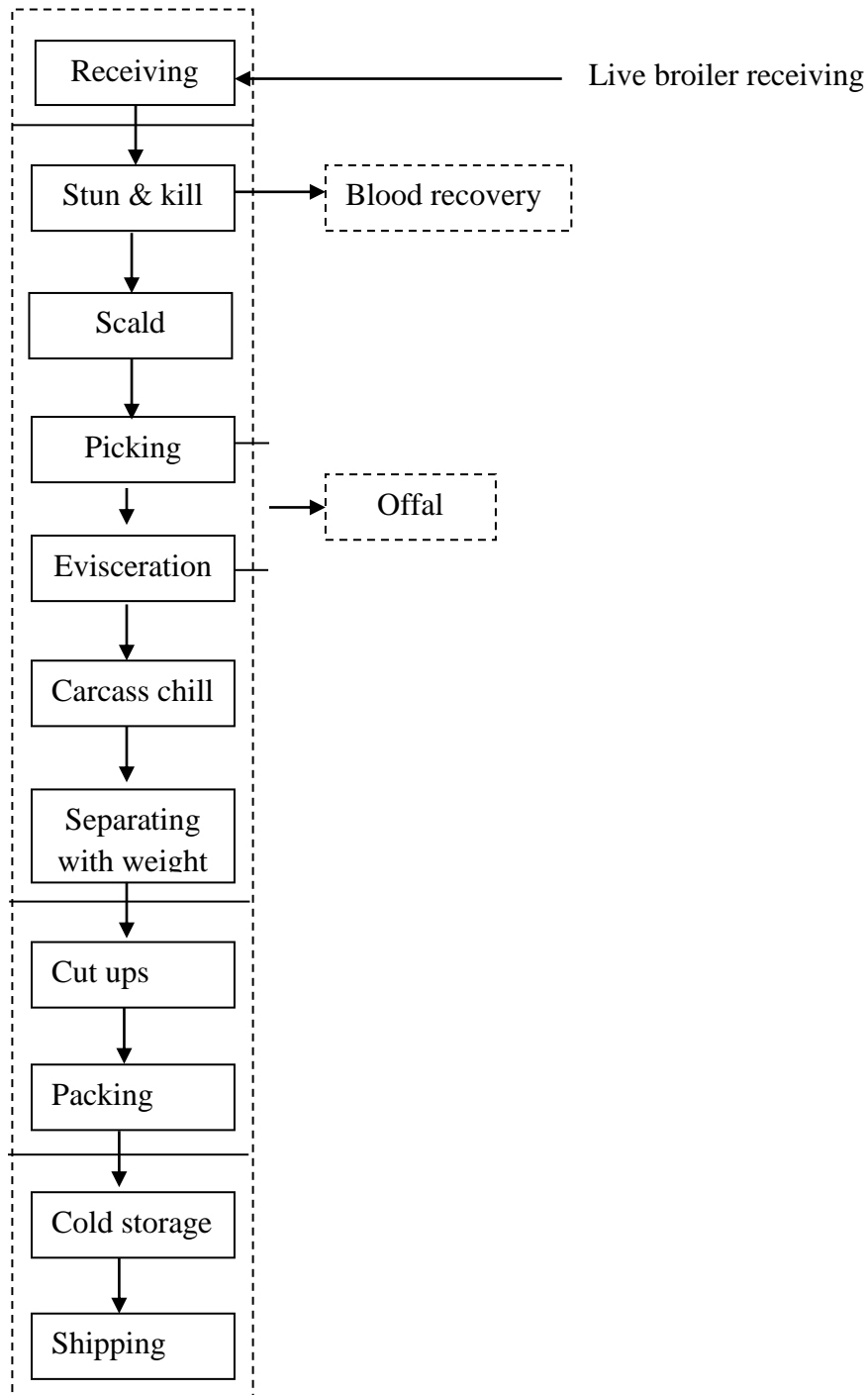


Figure 3.2 Typical block flow for a broiler meat abattoir or slaughtering plant

3.3.2 Broiler meat as food in Ethiopia compare to other countries

In earliest days chicken is the only affordable species to be slaughtered at home, as the prices of other species are high, and have increased substantially in recent years. As of many foreigners saying chicken is the cheapest species in other countries.

Poultry is the second most widely eaten type of meat in the world, accounting for about 30% of total meat production worldwide compared to pork at 38%. Sixteen billion birds are raised annually for consumption, more than half of these in industrialized, factory-like production units. [14] Global broiler meat production rose to 84.6 million tons in 2013. The largest producers were the United States (20%), China (16.6%), Brazil (15.1%) and the European Union (11.3%)[15].

Globally Poultry products are available as fresh or frozen, as whole birds or as joints (cuts), bone-in or deboned, seasoned in various ways, raw or ready cooked. The meatiest parts of a bird are the flight muscles on its chest, called "breast" meat, and the walking muscles on the legs, called the "thigh" and "drumstick". The wings are also eaten (Buffalo wings are a popular example in the United States) and may be split into three segments, the meatier "drumette", the "wingette" (also called the "flat"), and the wing tip (also called the "flapper").

CHAPTER FOUR

4. DATA PRESENTATION, ANALYSIS AND MODELING

4.1 Data collection

The analysis has been carried out in some of large scale broiler production farms. The data collection is based on a questionnaire (Annex-I). The questionnaire is given to 18 individuals who work in large scale poultry farms and out of which 12 are filled and returned.

Generally the questioner includes the following:

- General information like company name and year of establishment, education background etc
- Information about products and production time
- Main input resource information
- Information about market condition and their customers, to check whether there is demand or not
- Information about facilities fulfilled to have a productive farm
- Information about integration of departments
- Information about supporting institutes
- Information about training

Even though response rate is high relative to availability of large scale broiler farms in Ethiopia, the question of non-response bias still arises. The possibility exists that the firms who did not respond are different from the respondents, and this sample does not represent the non-responders. In order to reduce such bias the writer conducted extensive interviews with key informants and collected data from secondary sources. In the following section the writer shows some preliminary results of the analysis.

4.1.1 Survey Results

1. General information

As presented on the table 4.1 most of the employees who fill the questioner education level is between grade 11 and MSC holders (100 %). This figure indicates most of them are educated.

Table 4.1 Education Background

Level of education	Number	Percent
1-5	0	0
6-8	0	0
9-10	0	0
11-12	2	16.67%
10+1-10+3	2	16.67%
Diploma	4	33.32 %
Degree	2	16.67%
Msc	2	16.67%
PhD	0	0
Total	12	100 %

Most of large scale broiler meat producers last more than 5 years. But as the respondent shows there is no change within these years (Table 4.2) which means almost all farms have less productivity as the collected data indicates (no farm in the country can produce in full capacity), financial problem, limited knowledge etc.

Table 4.2 Year of establishment

Year of establishment	Number	Percent
1-5 years	0	0
6 – 10 years	0	0
10-15 years	9	75 %
>15 years	3	25 %
Total	12	100 %

And most of the employees have experience more than 5 years (75 %) Table 4.3. Even if these employees are experienced they cannot produce as planned or in full capacity.

Table 4.3 Year of experience

Year of experience	Number	Percent
< 5 years	3	25.005%
5 – 9 years	2	16.67
9-12 years	3	25.005%
>12 years	4	33.32
Total	12	100 %

Production

As shown in the following table most respondent said farms produce 101 to 500 tons of broiler meat (91.67 %). However most researches shows the demand per year is more than 8000 tons.

Table 4.4 Production capacity

Production capacity	Number	Percent
< 100 ton	1	8.33 %
100 – 300 ton	8	66.67 %
301 – 500 ton	3	25 %
501 – 701 ton	0	0
>701 ton	0	0
Total	12	100%

Input resources

In poultry farms the main input resource are day old chicks (DOC) or parent breeds, feed, skilled manpower, money, vaccine and different facilities etc. from all these inputs the bottle neck is importing DOC from abroad.

The basic start of a sustainable commercial poultry chain that is well in balance is the availability of day old chicks or parent breeds. There is a chronic shortage of day old chicks in Ethiopia. This leads to many farmers abandoning poultry keeping because their poultry houses will often be empty for months on end whilst they are waiting for new supplies from their breed suppliers. In this way, poultry farming is still a rather risky investment for many farmers.

Table 4.5 DOC purchase

DOC import	Number	Percent
Local	1	8.33 %
Abroad	11	91.67 %
Total	12	100 %

Table 4.6 DOC importing interval

DOC import	Number	Percent
< 9 weeks	0	0
9-11 weeks	0	0
11-13 weeks	0	0
>13 weeks	12	100 %
Total	12	100 %

As shown in the above table most respondents said after DOC order takes place it took more than 13 weeks (100 %).

In general most respondents said Ethiopia import regulations can be quite a challenge. To import breeding stock farmers need to apply for an import permit at the ministry of agriculture. With this permit the farmer needs to arrange a letter of credit at the bank. The shortage of foreign exchange and often contradictory terms of conditions are often delaying this process.

Table 4.7 Production time

Production time	Number	Percent
Broiler parents rearing		
< 23 weeks	11	91.67 %
23 - 30 weeks	1	8.33 %
Total	12	100%
Broiler parents layers		
<42 weeks	7	58.33 %
42 – 52 weeks	5	41.67 %
>52 weeks	0	0
Total	12	100%
Broiler grow out		
35 – 40 days	0	0
41 – 60 days	11	91.67 %
61 – 90 days	1	8.33 %
>90 days	0	0
Total	12	100%

The above table shows the farms use 60 to 90 days production time to grow the chicks. And the respondents said this is because of the chick cannot get their weight during 35 to 40 days. But this costs the farms a lot. So as per to the respondents broiler parents rearing take no more than 23 days, for broiler parents laying take more than 42 weeks and broiler grow out take more than 40 days. In poultry farms production time is the most important factor which affects the productivity; which means

1. Broiler parents rearing – when the farms rear chickens more than 23 weeks it is a waste of time because as per to the standard birds start laying eggs between 17 to 23 weeks. And as per to the respondents most of the farms are in safe production period
2. Broiler parents laying – if the farms let the birds to lay eggs more than 42 weeks it is not advisable or the farms must be sure that one bird can lay 3.7 pcs of eggs within a week time.
3. Broilers grow out – as shown above almost all farms grow their chicks more than 60 days. This is a big disaster for the farms because as time increases the birds needs more feed, vaccine, drugs, man power etc. it costs the farm a fortune.

In general in grow out process the farms can grow the birds for 35 to 40 days but most farms in Ethiopia grow birds for 60 to 90 days. And comparing the two growing times one farm can grow two batches instead of growing one batch for 90 days, the farms can double up their production.

Production Planning

Most respondents said that the projection is prepared by production department but its implementation and achievement is poor and it is indicated on table 4.9.

Table 4.8 Flock projection

Using flock projection	Number	Percent
Yes	11	91.67%
No	1	8.33%
Total	12	100%

Table 4.9 Flock projection implementation

Implemented & achieved	Number	Percent
Yes		
No	12	100%
Total		

Facilities

The table below shows all large scale broilers farms do not have modernized facilities

Table 4.10 Types of facility

House type & equipment	Number	Percent
Open	12	100%
Closed		
Air conditioned		
Not air conditioned	12	100%
Manual feeder & drinker	12	100%
Motorized feeder & drinker		

Integrated departments

The main drive of supply chain in any production and service giving companies is coordination, communication. As indicated below most respondents agree there is a gap in proper information transfer throughout the farms.

Table 4.11 Information flow throughout internal supply chain

Answer	Number	Percent
Yes	2	16.67%
No	10	83.33%
Total	12	100%

Linkage with support institution

Most of the respondents said that there are institutions which dedicatedly support their farms.

Table 4.12 linkage between support institution

Answer	Number	Percent
Yes	12	100%
No		
Total	12	100%

Training

All of the respondent said, they don't took training on broiler production methods but some farmers higher consultants to improve their production.

Table 4.13 Training

Answer	Number	Percent
Yes	0	0
No	12	100 %
Total		

4.1.2 Survey through interviews and secondary data

According to different researches more than 98% broiler meat in the country is indigenous chicken production and the remaining is commercial chickens. In general Production of poultry meat seems to be on a declining trend at the national level compared to the period 2003, and also compared to the population growth rate.

But on the contrary the marketing data shows there is a demand increases in each year because of the development of the country especially in urban areas. According to the United Nations (UN), the annual population growth rate for 2000–2005 is 2.46%, with the projected population for the year 2015 at 93,845,000 [30]. This is a clear indication that the poultry meat demand will be more than the supply in the near foreseeable future, and the following table shows the country meat consumption in 2020.

Table 4.14 Ethiopia meat consumption projection to 2020

	Projected annual growth total consumption (mmt) % 1993-2020	Total consumption (mmt)		Annual per capita consumption (kg)	
		1993	2020	1993	2020
Developed countries					
Beef	0.4	32	36	25	26
Poultry	1	26	34	20	25
Meat	2.8	88	188	21	30
Developing countries					
Beef	2.8	22	47	5	7
Poultry	3.1	21	49	5	8
Meat	2.8	88	188	21	30
Meat production Sub Saharan Africa	3.4		11		10
Meat consumption Sub Saharan Africa	3.5		12		11

As shown in table meat consumption increases slightly for developing countries while the meat consumption for Sub-Saharan Africa in general remains low. Ethiopian meat consumption is even estimated to be very low by the world standard, even less than Sub-Saharan Africa. Poultry consumption is estimated to be below 1 kg per capital. [27].

Broiler meat production

As indicated below currently large scale poultry farms in Ethiopia produce the following quantity of broiler meat. And most of the farms cannot produce at least half of their full capacity.

Table 4.15 2014/15 broiler meat production in Ethiopia

S.no	Company name	2014/15 production	Full capacity	Difference
1	ELFORA	483 ton	1000 ton	517 ton
2	ELERE farm	450 ton	650 ton	200 ton
3	Almaz poultry farm	168.5 ton	400 ton	234.5 ton
4	Alema poultry farm	156 ton	600 ton	444 ton
5	Tsedey poultry farm	15.6 ton	200 ton	184.4 ton

Imports and exports data on broilers meat

In developed countries broiler meat farms are one of the activities which contribute a high economic growth to the countries. Export of poultry products in Ethiopia is currently not applicable. In the contrary Imports of poultry products are a more diversified and multi-faceted story.

Trade Map shows the following import figures for poultry meat (in USD thousands). (Imports of poultry meat products to Ethiopia in USD thousands)

Table 4.16 imported broilers meat in Ethiopia

Product code	Product label	Ethiopia's import form world		
		Value in 2012	Value in 2013	Value in 2014
020712	Fowls, whole, frozen	0	0	17
020713	Fowls, cuts & offal, fresh/chilled	1	1	9
020714	Fowls, cuts & offal, frozen	5	221	58
020711	Fowls , whole, fresh or chilled	1	74	112

According to these figures Ethiopia imported for a total of 196,000 USD of poultry meat products in 2014 [32].

This implies broiler meat processing farms in the country cannot satisfy the demand so that the country is forced to import broiler meat to the country. But as can be seen above the processing farms produce under their full capacity.

4.2 Summary of the findings

As per to the questionnaire analysis, and writer observation the existing large scale broiler meat processing farms produce under their full capacity. But as indicated above the market data shows there is full of demand. And the main problem observed not to achieve their full production capacity is indicated below;

Problem findings of most large scale poultry farms by cause and effect analysis

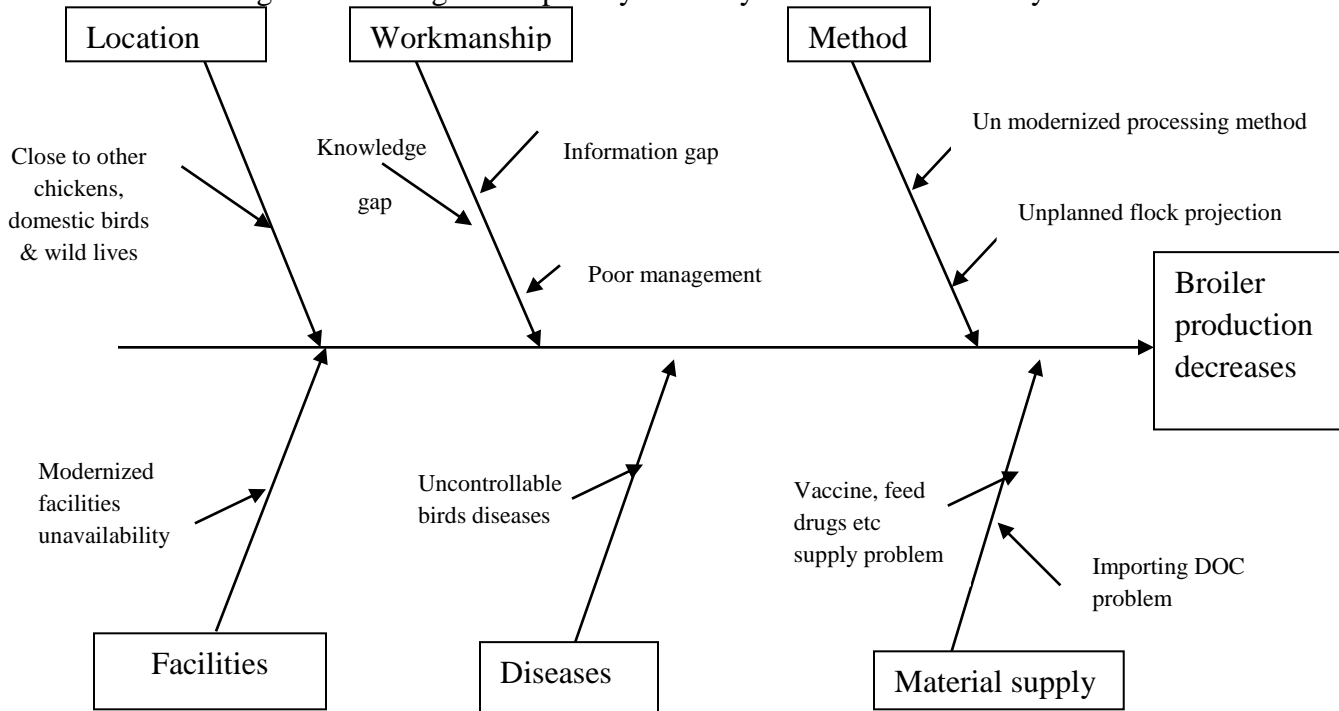


Figure 4.1 Fish bone diagram analysis

To clarify the above fish bone diagram, problems identified in large scale broiler meat farms are

1. Location – as stated above most of large scale farms are around Addis Ababa, Debre Zeit area. In now a day this area is the one which large population lives. And one of the criteria where chicken houses needs an isolated area (far from house hold chickens). So most of existing Ethiopian poultry farms is not fulfill this criterion.
2. There is an information gap throughout internal supply chain and because of this causes a poor management system;
3. Most of large scale farms in the country are categorized in sector 2 and 3 which means they are not using modernized production system and poor bio security system this has main impact on broiler meat productivity. When the writer say the poultry farms don't use modernized production system it is
 - All large scale poultry farms chicken houses don't have environment control equipments; which are; light are not controlled, they don't have air conditioning equipments etc.
 - Drinking and feeding system are not motorized – it has a big impact on the growth of the chickens (proportionality growth)
 - Poor Feed formulation – so to get the required weight of the chicken they will feed them more quantity for longer time
 - Un modernized abattoir or slaughtering plant
4. Most of the farms are not following standard flock projection. They use traditional method to grow birds as the questioner result shows even if most of the farms prepare flock projection most of the farms implement the plan less than 50 %
5. Input materials availability gap
 - Vaccine and chemicals – because of foreign currency problem, unplanned procurement system, knowledge gap (using limited varieties)
 - DOC importing – long purchasing lead time (farms import DOC in 13 weeks through air transport but they can go up to 9 weeks by seeing their flock projection), information gap
 - Feed – knowledge gap, they use limited varieties of recipes but large quantity of feed to get the preferable bird weight, information gap
 - Transporting vehicles problem – vehicles quantity do not consider the process and the product

6. Uncontrollable birds diseases – most of the time it is because of the above problems
7. Different facilities shortage like Cold storage area, transportation.

Even if there are external factors (Location of the farms) which influence the production; most of the sated problems can be solved by the farms So if the above problems are categorized or summarized; large scale broiler meat processing farms have poor facility, inventory management problem and there is an information gap throughout the internal supply chain.

Based on the above identified problems in a large scale broiler meat production farms in Ethiopia, the writer tries to show how these problems affect these farms. Due to the above problems most Ethiopian poultry farms

- Have low production capacity and their production cost is high
- Poor inventory management system, most of the farms don't know what inventory should be stocked at each stage in a supply chain, how much inventory should be held as raw materials, semi finished, or finished goods, what are the optimal inventory levels and reorder points, But as indicated above most of Ethiopians' large scale poultry farms can't manage this, and the main reason for this problem is because of unplanned flock projection or not implementing the planned projection.
- Most of the industries are located or surrounded by lager number of population. And this will make difficult to control birds' disease.
- The writer cannot say facilities problem are comes purely from information gap or unplanned production or else, it is also because of financial problem. But if these farms work on; of having smooth information flow and utilizes its resources in a proper way by considering production schedule at least the farms can minimize this problem.
- Information gap - As stated above most of the problems are created because of an information gap. Having timely and accurate information holds the promise of better coordination and better decision making. But as can be seen above because of information gap, people cannot make effective decisions about what to produce and how much, about where to locate inventory and how best to transport it.

According to the writer observation the major constraints faced by these farms are summarized as follows:-

- Low productivity
- Largely unorganized, dispersed and decentralized activities
- Lack of knowledge – not knowing effective production methods
- Lack of continuous technical training
- Non-conformity to quality standards
- Traditional mode of technology

Generally availability of facilities, information flow and proper inventory management are the main drives of internal supply chain of any processing sectors and one of the evaluating drives whether the production sector has an effective and integrated supply chain or not. So this study concludes Ethiopian's large scale broiler farms have poor internal supply chain.

4.3 Problem consequence

In general cause of lack of integrated internal supply chain in the large scale broiler production farms, the farm faces following consequence.

- Production cost increases
- Product quantity decreases
- Inventory cost increases
- Replenishment lead time increases
- Transportation cost increases
- Labor cost increases
- Relationships across the supply chain getting worsens
- Profitability decreases

4.4 Overcoming the problem

According to the master plan of the country is to use the potential contribution of the poultry industry to improve food security, meat consumption and nutrition, and plan to increase the

production by 235% in 2020 [34] so that this sector can play a key role in activating economic growth and equitable development in the country. However, as indicated above existing broiler farms are not enough to satisfy the existing demand and also they are not productive enough because of the following core problems:-

- Disintegrated and unorganized
- Lack of knowledge – not knowing an effective production methods
- Low productivity
- Lack of technical training
- Low product quality
- Facility problem because most of the facilities are not modernized or traditional equipments

To defeat the existing problem increasing poultry farms will not be the only solution, the existing poultry farms must use modernized processing system or they have to follow poultry standards to produce broilers. Mostly as stated above the processing system is not that much complicated or don't use sophisticated machineries or supplementary equipments.

To overcome the above problem or to have a smooth processing system the existing or new poultry farms must focus on their internal supply chain management. So this research analyzes and gives solution based on the following four drives of supply chain and also this research tries to improve internal supply chain of large scale broilers meat farms by considering international standards.

1. Facilities: In broilers production house location, quantity, size, equipment (feeder and drinkers) have big effect on the output if not assigned or calculated correctly
2. Inventory: includes all inputs, work in process, and finished good within a supply chain. In broilers production this can be calculated as per to poultry standard, so that it will be easy to control the process
3. Transportation: entails moving inventory from point to point in the supply chain.
4. Information: consists of data and analysis concerning facilities, inventory, transportation

4.4.1 Components to improve internal supply chain

To improve the internal supply chain of poultry farms the first thing to do is to fulfill all necessary facilities for broiler production based on the flock projection. As stated above most of the farms cannot meet or produce as per to the plan or flock projection. For any production sector planning is the base for each department, so that each parties of the internal supply chain can prepare themselves for the necessary facilities, working methods etc. So this study tries to improve the internal supply chain of large scale broilers farms by giving theoretical solution, develop flock projection database and developing simulation model based on broiler production standard and international experience as indicated below.

Most of large scale poultry farms start operation by importing DOC from abroad because as stated above there are no companies which produce parent stock. So the process starts with importing DOC, after arrival they are placed in broiler parents rearing house and they will be reared for 23 weeks. After 23 weeks this parents will be transferred to broiler parents laying house where they can lay eggs. Here they are staying for 42 weeks until then they lay eggs, then the parents will be culled. The eggs which are layed will be collected every day and will be transferred to hatchery. Here to hatch an egg it takes 21 days after vaccinating each chicks they will be transferred to broilers grow out. In the grow out house chicks will grow for 5 weeks only by that time they will be 1.8kg (standard weight of live birds). Then these birds are transferred to slaughtering house then packed and transferred to cold storage or freezer. To be scheduled and on time the input materials and facilities have major value in broilers production and must be fulfilled.

4.4.1.1 Input supply identification and selection

Farm input required for a broiler farm includes farm equipment (drinkers, feed trays, brooders, and feeders), electronic fixtures and other consumed items (feed, vaccines & medicines, rice-husk or saw-dust, water, electricity, etc.). And this input supplies can be identified and quantified based on the farm plan or flock projection. To have an effective broiler farm the following inputs must be available.

Day Old Chicks

As stated on the literature part there are not parent breeds hatcheries in the country so most farms import the DOC from abroad. The recommended selection of DOC; the chicks should be of uniform size, active, alert and bright eyed. The shank or leg covering (skin) of healthy chicks appears bright and shiny.

Feed

Broilers are usually fed with the following two types of ration: [22]

- **Broiler starter:** It is fed to the broiler birds up to five weeks of age.
- **Broiler finisher:** It is fed to the broiler of more than five weeks of age and continued till the age of marketing. Feeding three or four times each day will stimulate feed intake and prevents wastage. Percentage requirement of different ingredients in starter and finisher diet is given in

Table 4.17 Broiler Starter & Finisher Diet

Ingredients	Starter diet (%) (required)	Finisher diet (%) (required)
Maize	44.25	44.10
Rice polish	10	20
Ground nut cake	15	11
Sun flower cake	15	11
Fish meal	6	5.30
Meat meal	6	5.50
Blood meal	0.25	0.2
Animal fat	2	1.25
Bone meal	0.75	0.6
Lime stone	0.5	0.7
Salt	0.25	0.25

Ingredients	Starter diet (%) (required)	Finisher diet (%) (required)
Mineral and vitamin mixture	0.1	0.1
Total	100	100

This starter and finisher feed can be obtained in prepared form, from the feed mills.

Vaccination

Vaccination can be provided to chicks through injections, can also be mixed in the water and also through eye drops.

Fumigation and Spraying

It is essential to check all equipment and walls of the broiler house carefully that they are clean, and washed with disinfectant solution, and dried. The rooms should be white washed and sprayed before the arrival of birds.

Disinfectant solution can be prepared with Phenol, Potassium Permanganate, Carbolic Acid and Formaline. A solution of Sodium Hydroxide/Caustic Soda with warm water can also be used to clean the house.

To sanitize the broiler house from germs and insects, it is fumigated with Formaldehyde Gas, which is produced by putting Formaline on Potassium Permanganate. The rooms should be vacant and sealed for 30 minutes after the fumigation so that the gas infiltrates in every corner of the room.

4.4.1.2 Facilities identification and selection

Poultry house location

To implement poultry industry the first thing to consider is to specify the location. The following careful reviewed of the standard requirements for a modern poultry farm.

1. Project site climate condition
 - Altitude:

- Rainfall:
 - Wind speed (annual Ave) and direction :
 - Temperature:
 - Humidity:
2. Poultry population in the surrounding
 3. Disease handling practices

Housing

The chicks should be kept in a clean, dry and well-ventilated room. Broiler house should have proper ventilation as this provides the birds fresh air and carries off moisture. The entire building including litter and all equipment should be fumigated.

House quantity and capacity: - to have an effective poultry plant the production system must go under what science justification, which is

Table 4.18 Acceptable flock density

S.no	Description	Flock density
1	Broiler parents (DOC)	7 birds/m ² -females & 4birds/m ² - males
2	Broilers parents layers	5.5 birds/m ²
3	Broilers grow-out	22-24 birds/m ²

So according to the above table the bird placement in each house will determine the size of houses.

And the processing plants should have a capacity based on

- Hatchery must have a capacity to hatch eggs laid from broilers parent's layers.
- Abattoir capacity must consider broilers grow out output

Equipments: - drinkers, feeders, silos, ventilation system, abattoir processing equipments and hatchery section equipments must consider flock quantity.

Feeders and drinkers

It is essential to provide adequate feeder space. Adequate drinking space should also be provided to the birds. The drinker should contain fresh, clean and cold water. It is necessary to provide extra water during summer.

Table 4.19 Broilers rearing house feeders and drinkers quantity

Equipments	Number of female	Number of male
Feeder	12.67 / pan	7.74 / pan
Drinker	4.9 / nipple	3.29 / nipple

Table 4.20 Broilers laying house feeders and drinkers quantity

Equipments	Number of female	Number of male
Feeder	12.67 / pan	6.6 / pan
Drinker	4.9 / nipple	7.4 / nipple

Table 4.21 Broilers Grow out feeders and drinkers quantity

Equipments	Drinking lines technical features	
Feeder	Number of broilers per pan feeder	(maximum capacity n. 80 birds/pan)
Drinker	Number of broilers per nipple	(maximum capacity n. 15 birds/nipple)

Lighting

Most broiler growers provide 24 hours light during brooding and early growing period. Recent research conducted in windowless buildings, using intermittent lighting of 1-2 hours period, has indicated significantly improved feed efficiency.

Initially, for first fifteen days, light intensity should be 40-60 watts per 200 sq. ft of space and this can be replaced by 15 watts bulb in the beginning of third week.

Brooding house

Proper brooding temperature is required to keep the chicks in comfort. In the first week, 95°F is quite comfortable. For the first one week, it is also essential to observe four to five times daily the condition (temperature) of the chicks. They should neither huddle nor move away from the brooding hover, but should be moving around evenly. As chicks grow, the temperature may be reduced at a rate of 5°F per week until approximately 70°F is reached in the sixth week.

Grow out house

The chicks live in large houses which hold as many as 20,000 birds. These grow-out houses are kept at about 85° F (29.4° C) through heating and ventilation controls.

Different equipments: - these are materials which are used to transport chickens from one station to another trucks, Trailers, Chick boxes: - to collect chicks from hatchery and to transport it to broiler grow out, Setter trolleys; used in the Hatcher to hold eggs in the egg cold room and in the setters, Farm trolleys: - used to collect eggs from broiler parents laying house, Chicken baskets: - to hold chickens from one station to other etc.

4.4.1.3 Information flow

As of the input supplies and facilities smooth information flow between departments has an effect on the productivity of the farm. All production and service giving companies has objective and to achieve this, all parties in a company must work integrated. And the key drive to work integrated is information flow. Information flow is a kind of inter-communicational flow between internal supply chain members. The information always includes forecast information, promotional plan, purchase order, order confirmation, shipment and inventory information and replenishing requirements, etc. The information exchange can trigger, control and record the flow of product. With the ICT development, more and more information are exchanged easily instead of paperwork.

Information flow exists always even if no coordination in the internal supply chain. However under the circumstance of low integration and bad coordination, the flows move unsmooth which will result in delay, redundancy and inefficiency. While, integrated supply chain will accelerate the flows, with which the supply chain can produce more.

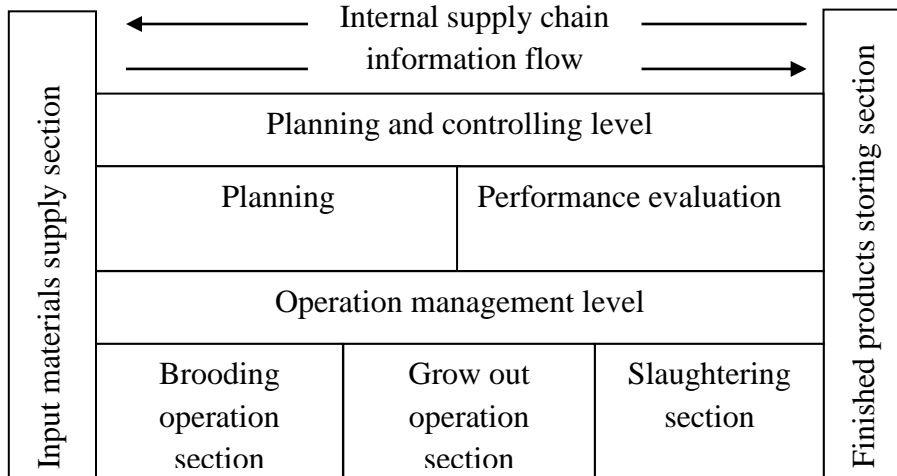


Figure 4.2 Information flow throughout the internal supply chain

The above figure shows the flow of information throughout the chain. Different information in broilers farm which is valuable to its productivity are

- Planning or flock projection
- Based on this information purchasing department order DOC, feed, vaccine, drugs
- Production department is responsible department to prepare the plan and pass the information horizontally and vertically
- Material management according to the planned schedule will know the input material required, chickens production at the farm, how many birds are processed in a slaughtering plant and finished products delivered to distribution department.
- Above all information flows from beginning to end, similarly the result or the achievement or failure information must pass from the end to the beginning.

4.4.1.4 Inventory management system

Materials management is the planning, organizing and controlling of the flow of material from its initial purchase stage, through internal operations, to the distribution of finished goods.

Below there is a database system which shows the projected production. So it makes easy to control the inventory, which is what to order, each week farm production, weekly hatchery production and slaughtering production and finished products.

4.5 Developing a flock projection analysis database system and a model

The study tries to develop a model which optimize the process through out the internal supply chain of a broiler production and a database system which helps to know the input DOC quantity, workin progress chickens and out put chicken quantity.

4.5.1 Broilers placement schedule

As stated above a database system is prepared to know the flock projection by considering international standard and this database system is prepared for three broilers rearing houses. So large scale poultry processing farms that have three or less broilers rearing houses can use the following database. To make it clear the database system is represented with example and the database system is presented in Annex III.

Discussion

The excel data base (Annex III) considers three broiler parents rearing houses to start the production and to be followed by six broiler parents laying houses which each house can accommodate all chickens from one broilers rearing house. And twenty one broilers grow out houses to accommodate the hatched eggs.

To define the above house quantities and size, the base point is required production quantity per year or the reverse which means for the existing farms, can prepare the flock projection by seeing their house and processing plant capacity. In this specific case it is planned to produce more than 6000 tons of broiler meat per annum. So based on the birds density standard each houses are sized and quantified. Other considered factors to prepare the database are listed below

Broiler parents rearing

- According to recent custom data the lead time to import DOC is 9 weeks and each BPR houses placement will takes place every 9 weeks importing time gap.
- Acceptable mortality standard is 5% so it is considered
- DOC's raised for 23 weeks

According to the input data the DOC placement is indicated on the following graph.

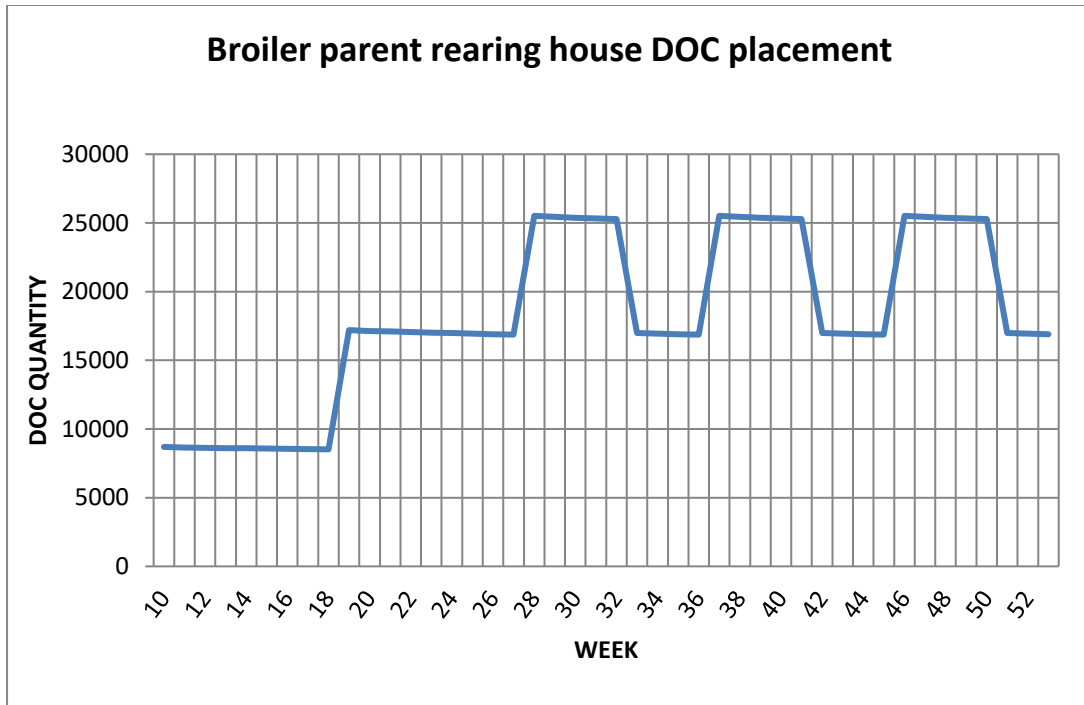


Figure 4.3 Broiler parent rearing house placement

As indicated on the graph DOC rearing pick point is on week 28 then it stays for 5 weeks then drops down for the next four weeks (because one house will dispatch the reared DOC's) and this four weeks gap is for cleaning and maintenance work. As indicated on the graph after week 28 the cycle will repeat again and again throughout the life time of the farm.

Broiler parents laying

- Once the birds replaced they will stay for 42 weeks
- Acceptable mortality standard 9% and 3 % culling is considered
- One bird can lay 159 eggs per 42 weeks

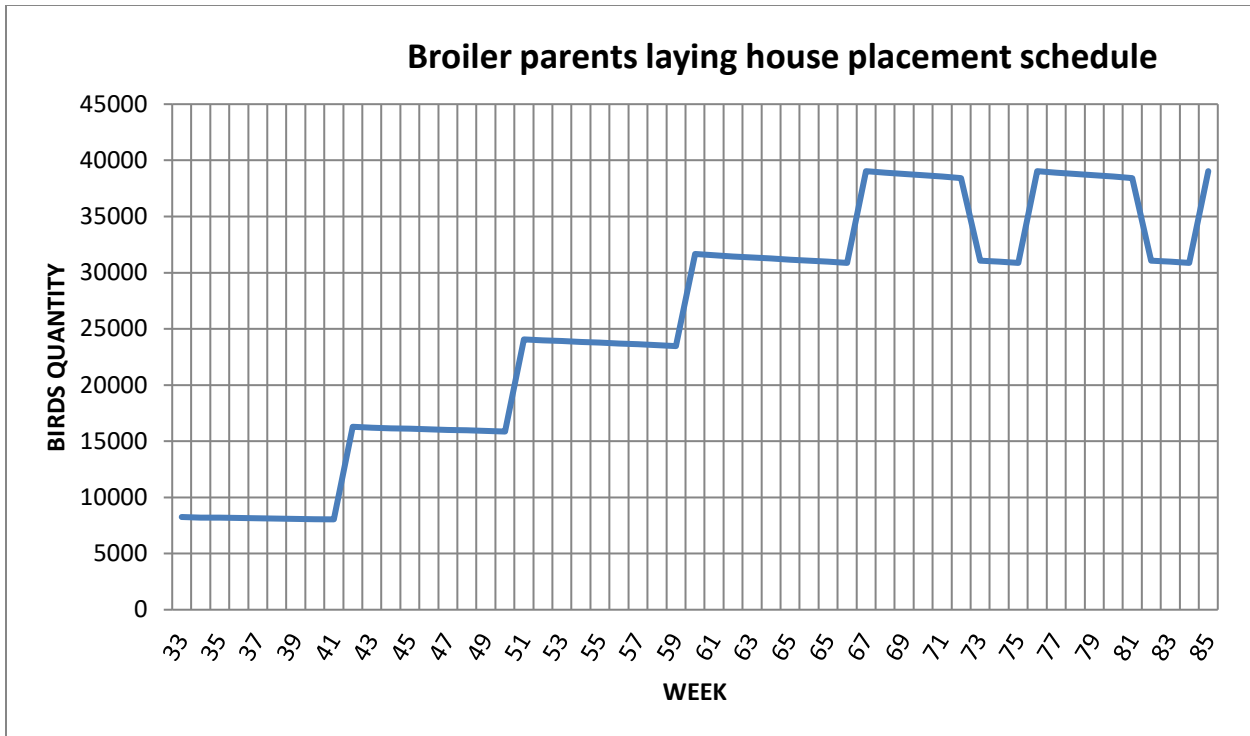


Figure 4.4 Broiler parent laying house placement

After receiving birds from BPR they start laying eggs starting from week 33, the pick production at this stage will start when the five houses placement then after as indicated on the above graph the cycle will repeat again.

Hatchery

- If there is a good hatching management 85% hatchability is achievable, so in this case 85% hatchability is considered
- 21 days to hatch eggs

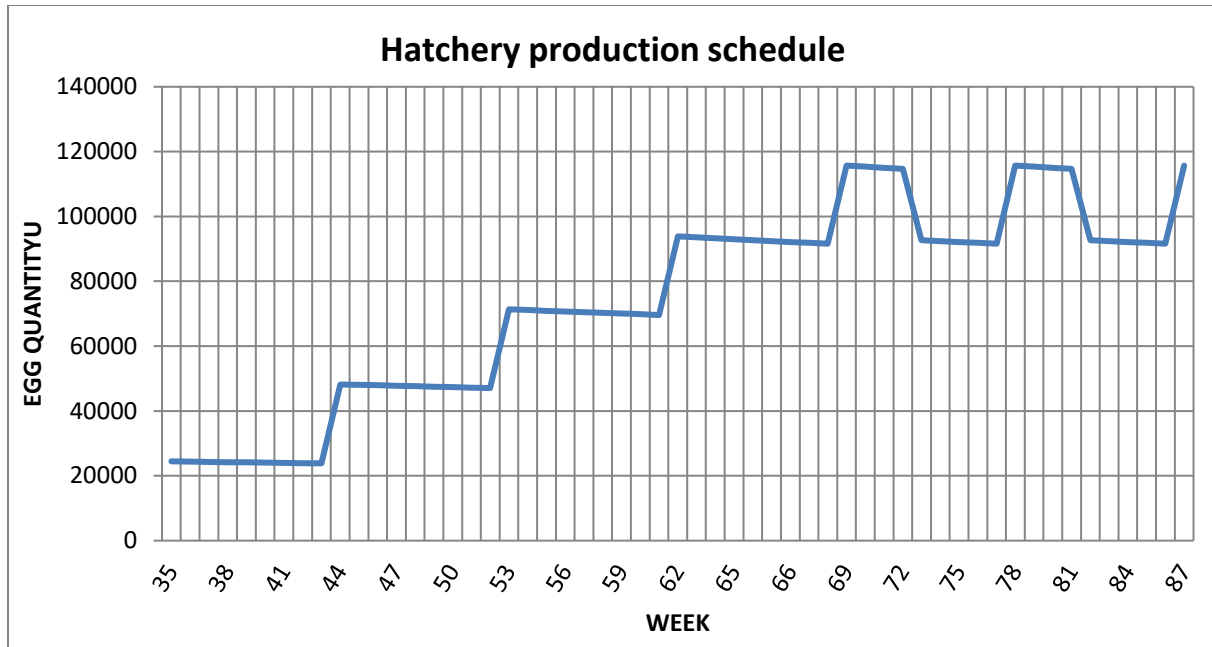


Figure 4.5 Hatchery production

Similar to the BPL graph until it gets eggs from five BPL houses or pick egg production of BPL houses hatchery chickens production increases and it reaches its pick production on week 69. And as indicated above after week 69 the production cycle will repeat until the life time of the farm.

Broilers grow out

- Acceptable mortality standard 5% is considered
- Birds will stay only for 5 weeks
- One live bird weight at fifth weeks is 1.8 kg

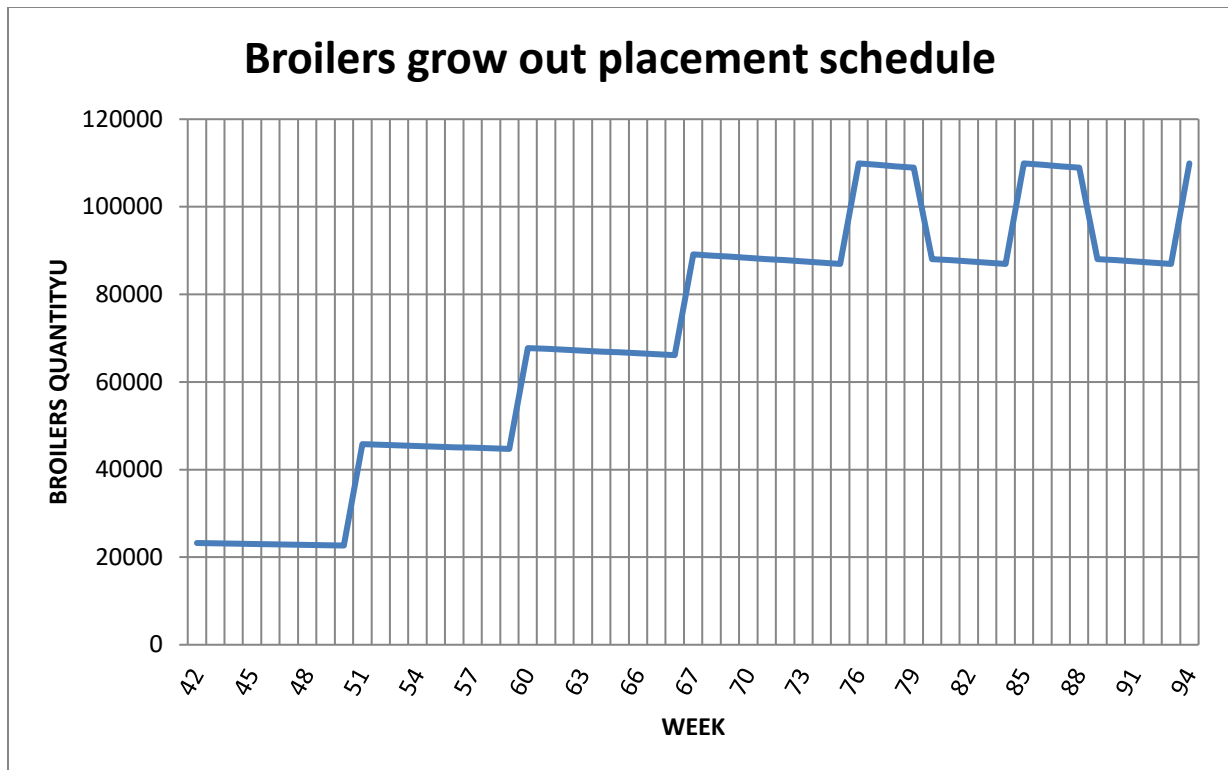


Figure 4.6 Broilers grow out placement

For the large scale broiler meat producers this stage is the final output where they get product and as shown on the graph the pick production is 109,909 and the minimum production is 86,980 so average production with the allocated farm houses is more than 6000 tons per annum.

As stated above the database is represented with example, the example clearly shows every movement through the poultry processing farm and the main aim is with three broilers rearing house with the given house size how many broilers meat per annum will be the output. And according to the database system it is more than 6000 tons of broilers meat per annum. And as can be seen from the data base any one can see weekly production of the farm and this helps the workers to have all information required and can easily control the inventory and this will improve the working system of the farm. Because

1. Once the schedule is known it will be easy to prepare facilities which are required for the processing farm ahead of time
2. All inventories can be easily identified and quantified. For instance input DOC which are imported, chickens on process, output products, cold storing house capacity

3. One of the supply chain drive is information if the above information is distributed to every responsible department for instance purchasers will know when to order input materials eg. DOC, every section of the farm workers can plan, when the second cycle arrive at their section etc, and marketing department will be certain about their product quantity and delivery schedule.
4. It is easy to allocate transportation with the above information

As stated on the literature part chickens are very sensitive animals to produce so to be effective and to meet the projected output, if and only if every facilities are fulfilled which are stated above in section, Input materials and facilities.

Generally by taking the above database as a benchmark any poultry farms can make their own database.

4.5.2 Optimizing internal supply chain via production modeling

4.5.2.1 Model building process

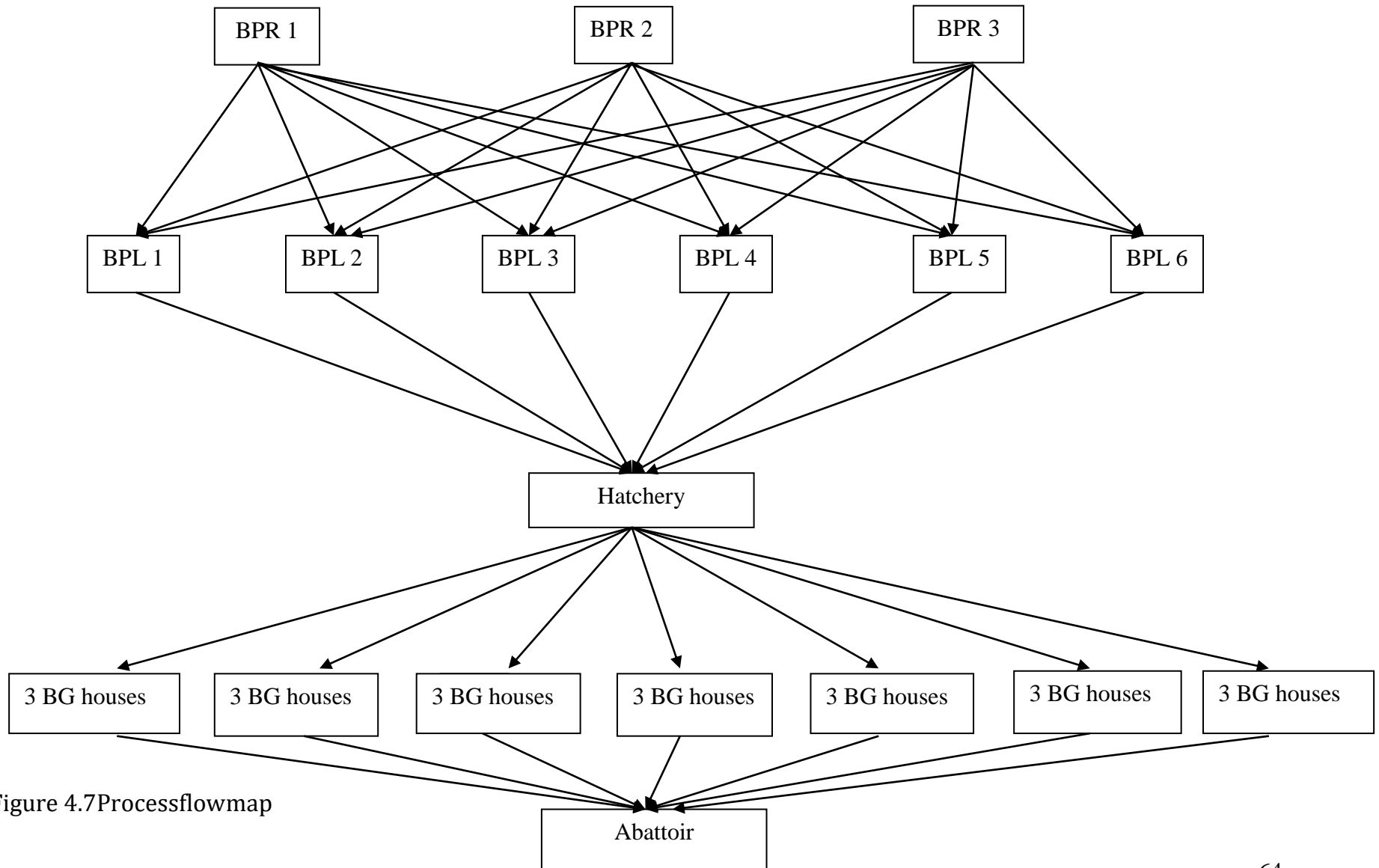


Figure 4.7 Process flow map

The structure of the poultry processing internal supply chain is shown in Figure. It incorporates a supplier of DOC for the broiler farms, the DOC Supplier produce DOCs and deliver to the broiler farms. The poultry processing plant place a batch of DOCs in a broiler parents rearing house (BPR). After 23 weeks these reared DOCs transferred to one broiler parents laying house (BPL) and they are staying there for 42 weeks and laying eggs throughout their stay. Those eggs transferred to hatchery and it is hatched in 21 days and transferred to broilers grow-out (BG). And they grow for 5 weeks and transferred to abattoir to be slaughtered. This configuration (1/2/1/7/1) is the reference for designing the model of discrete events in the simulation software used (Arena).

Discreet event simulations change in state happens at specific times over the run of the system. The evolution of the discreet event system model is governed by a clock and a chronologically ordered event list. That is, events are linked in the event list according to their scheduled order of occurrence (Altiok & Melamed, 2002). According to (Kelton, Sadowski, & Sturrock, 2007) most discreet event simulations are executed in the event orientation thus it is very important that one be able to map out the events of a process.

The chosen discrete event simulation software is ARENA version 14.00 created by Rockwell Automation Inc.

4.5.2.2 Findings and input Analysis

Simulation models are so data dependent such that the information collected has to be accurate so as to actually create reliable outputs which resemble the real system. When working with a lot of variable information it is always good practice to analyze it so that the model can end up using what is only relevant to the problem. In this chapter a lot of information will be presented in tables and the relevance of this data to the problem will then be explained further.

Facility information

Since the model is to be as realistic as possible then one should consider the capacity limitations of all the equipment that is used in the production. The data provided in table is a representation of the constraints/limitation for equipment used in the production process.

Table 4.22 Houses capacities and capabilities

S.no	Description	Number of house	Capacity
1	Broiler parents rearing house	3	3 fully equipped house
2	Broiler parents laying house	6	6 fully equipped house
3	Broilers grow out	21	21 fully equipped house
4	Hatchery	1	1 fully equipped house
5	Slaughtering house	1	1 fully equipped house

Time study

Data obtained from the collected data on five stages of the production process will be used as inputs in the simulation model. Also it is based on the standardized production time for each process.

Table 4.23 Processing times

S.no	Description	Process time
1	Broiler parents rearing house	23 weeks
2	Broiler parents laying house	42 weeks
3	Broilers grow out	5 weeks
4	Hatchery	21 days
5	Slaughtering house	1.8 sec

4.5.2.3 Computer Model

The current situation is modeled using the simulation software ARENA14.0. But this version is a training or evaluation mode so this software has a full functionality for building and executing training size. It cannot run larger number of entities.

4.5.2.4 Model Translation

DOC importing and receiving operation

This is the first stage of the simulation where the entity that moves through the process is created. So in this stage the time required to import DOC is 9 weeks, which is from ordering to receiving. Each arrival is considered as batch

1. The entity product batch is created and the arrival time of each batch is 9 weeks
2. After arrival each batch is transferred to BPR houses
3. This model assumes one house is fully equipped. So the model considered three fully equipped houses as its resources and in BPR house one batch stays for 23 weeks.
4. During their stay as per to international standard if there is good handling it is expected a 5% mortality in each batch so the model uses a decision module to disposes the mortality
5. And to exit from these houses the model uses Enter and Route module to transfer the batch to the next station.

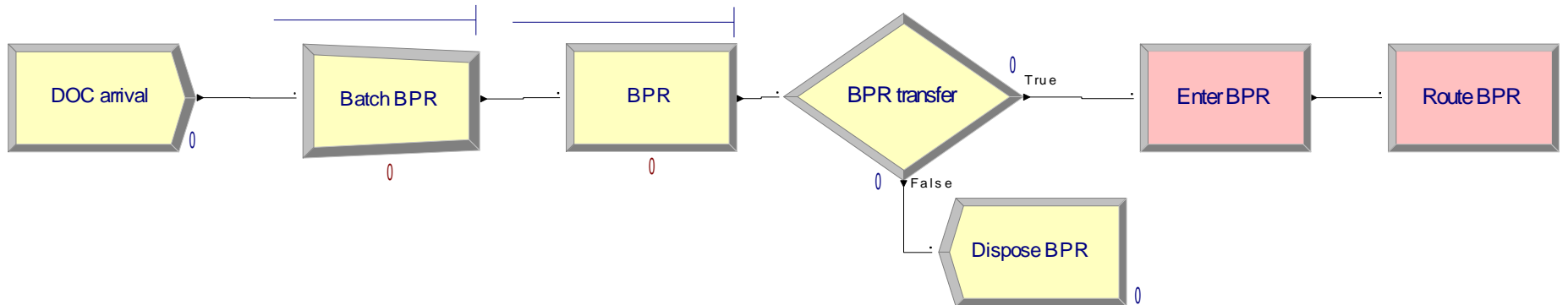


Figure 4.8 Simulation model for DOC receiving and broiler parents rearing

BPL houses (second station)

1. By using station module the transferred batch is received from BPR houses
2. There are six BPL houses which are fully equipped. Here when the batch arrives without adding values or without laying eggs they stay for 2 weeks so in the model the writer use Delay module.
3. After 2 weeks the batch starts to lay eggs for 42 weeks. So to show this process the model uses process module. Per week one batch expected to lay eggs /house but as stated above this model is build and executed on training size version. So the eggs are also considered as a batch.
4. To separate the eggs from the original entity the model uses a Separate module. Because in this process the original entity will stay for 42 weeks and continues laying eggs.
5. By international standard in BPL house it is expected to have 9% mortality and 3 % culling process so in total 12%. So to consider this loss the model uses a Decision module to dispose 12% during 42 weeks.
6. There is another decision module which is used to remove the whole batch after 42 weeks stay. Till the batch reaches 42 weeks age the process repeats its process by this decision module
7. Route module uses to transfer the eggs to the next station

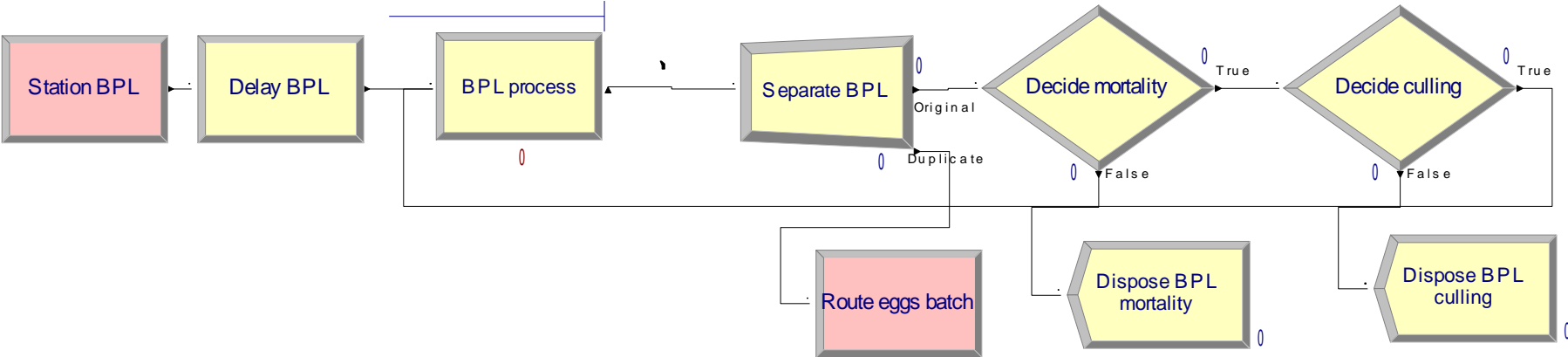


Figure 4.9 Simulation model for broiler parents laying

Hatchery

1. Station module is used to receive the transferred egg batch from BPL houses
2. Batch module is used to show eggs are hatched in a weekly bases in a batch system
3. Process module is used to hatch the eggs in 21 days.
4. Here mortality rate is considered 15% (as per to international standard) so to dispose the mortality decision module is used
5. Route module uses to transfer the hatched eggs to the next station

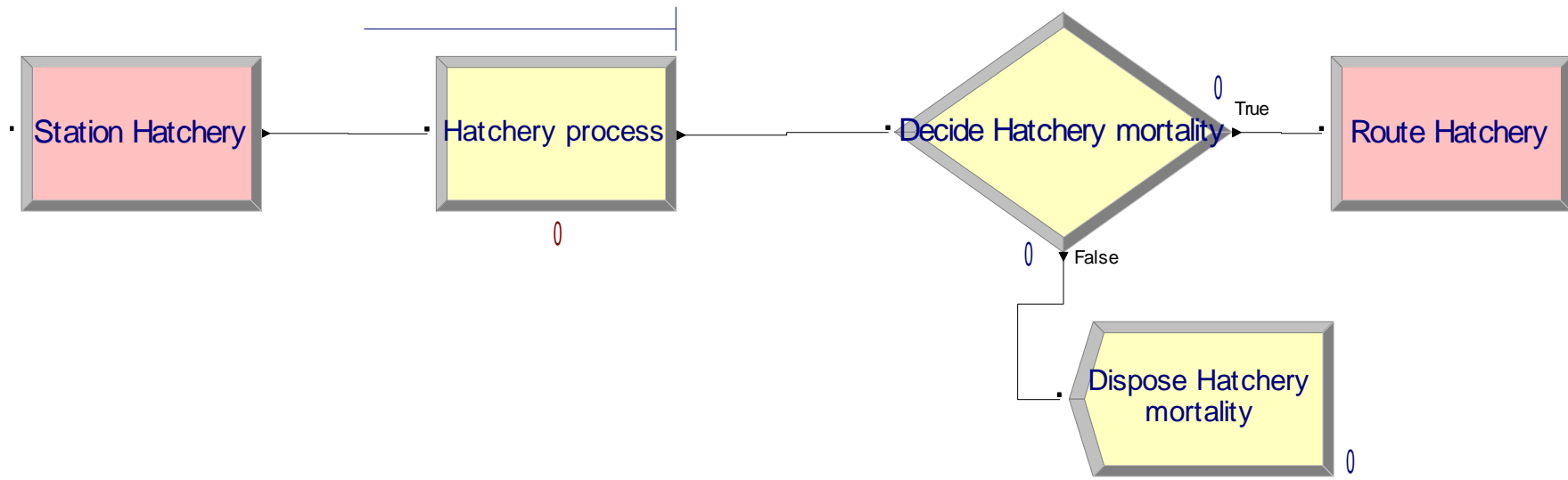


Figure 4.10 Simulation model for broiler hatchery

Broilers grow out

1. Station module is used to receive the transferred hatched eggs batch from hatchery
2. BG process for 35 days. Process module is used to grow the hatched eggs for 35 days
3. In this stage 5% mortality is expected so to consider this decision and dispose modules are used to dispose the mortality rate
4. To transfer 95% to the next station the model uses Route module

Slaughtering house / Abattoir

1. Station module is used to receive the transferred broilers batch from BG houses
2. The slaughter house is equipped. So the model is designed with specified capacity (1 bird/1.8 second) and it is represented by process module
3. After slaughtering process the product is ready to be stored.

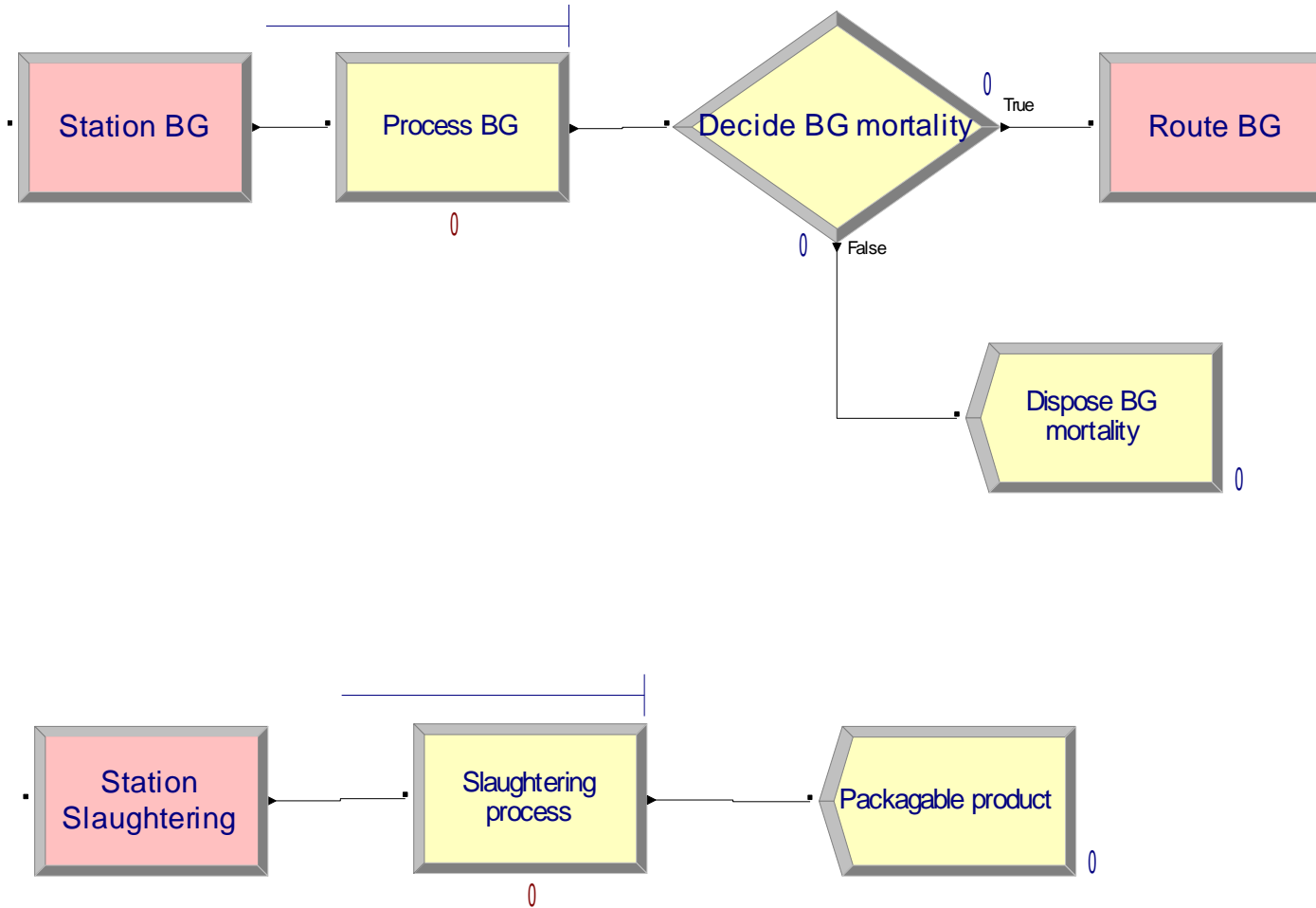


Figure 4.11 Simulation model for broiler grow out and slaughtering section

4.6 Simulation result

After having run the model for a year the following data is found about the number of batches that leave the system to packaging. And according to the simulation BPR and slaughtering sections are the one which are loaded and this shows that all farms must give emphasis on these areas.

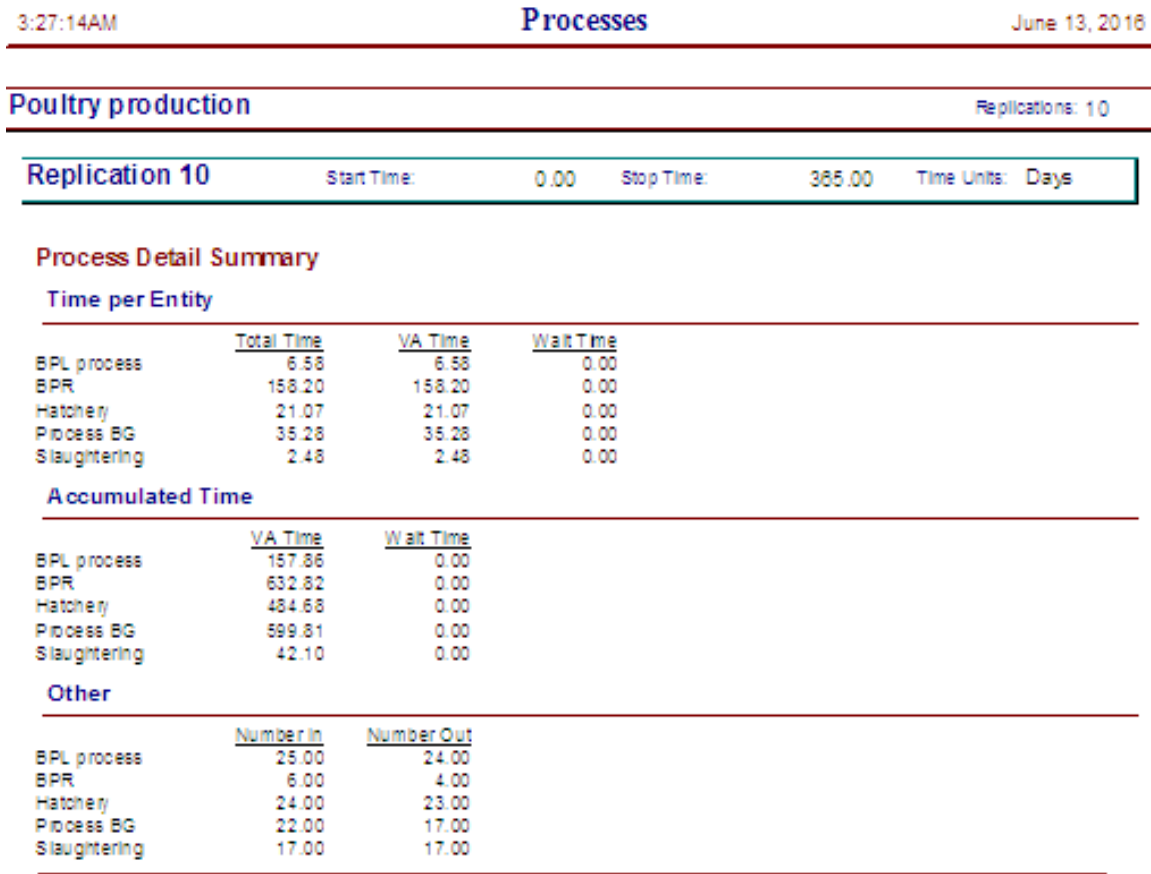


Figure 4.12 Process detail summary of simulation result

Resource allocation

Regarding resource allocation the study uses the lump sum instead of quantifying each resource. Here in poultry production the houses quantity and size is the main factor for having production as planned or not. Here the writer considers one house as it is fully equipped with all required resources.

According to the simulation if any farm considers one house Broiler parents rearing (BPR) then there must be 2 houses of Broiler parents laying house and for the hatched eggs there must be 7 houses of Broiler grow out. So the configuration is 1 / 2 / 1/ 7 and it is similar to what initially the writer started with which is 1/2/1/7. In real world simulation can lead the human planner but it cannot give the real time data so farms can use this model by adjusting the resource capacity.

4.7 Model Verification and Validation

Verification and validation of a model is required for the readers to gain confidence on the results of the simulation. To get the expected result, throughout the process of this study, and the collection of data, component of the model is transparent with the intent of providing all the necessary information to show the model's purpose, sources of information, structure, and results to the best of the writer knowledge.

With a system where an optimal solution is part of the goal, an optimization process is included in the result processing. The system is optimized and experiments are run again with the optimized model until with the necessary accuracy has been found.

4.7.1 Model verification

Model verification is concerned with building the model right. To verify the model the following points are carefully seen by the writer. And also the model is adjusted and the experiments are repeatedly run without any problem.

- The writer checks the flow diagram which includes each logically possible action a system can take an event occurs, and follow the model logical for each action for each event type
- The writer closely examine the model output and it is reasonable when it compared with the input parameters
- And the writer also checks whether the flow of the process is according to every flow and steps mentioned above.

4.7.2 Model validation

To validate the model reliability the writer use the excel flock projection for comparing the input quantity and out product.

Validation of model assumptions

Data assumptions are based on the collection of reliable data and it is correct statistical data.

Input data considered in the simulation are

1. Arrival time, interval times between processes and
2. The simulation also identifies appropriate probability distribution and it is close to the real time data
 - BPR processing time – Beta distribution
 - BPL processing time – triangular distribution
 - Hatchery processing time – Normal distribution
 - BG process – Lognormal distribution
 - Slaughtering or Abattoir – Normal distribution
3. This study validates the assumed statistical model by using the excel database. By running the simulation for a year time the comparison is presented as follows

Table 4.24 Model validation

S.no.	Description	Excel data base	Arena simulation
1	DOC order & arrival per year	6 batches	6 batches
2	BPR processing per year	3 batches completed and 3 batches on process	3 batches completed and 3 batches on process
3	BPL received	3 batches	3 batches

S.no.	Description	Excel data base	Arena simulation
4	BPL process and laying eggs	27 week production of egg batch	24 egg batch transferred to hatchery 1 on process, 2 disposed
5	Hatchery	24 week production	1 on process, 1 disposed and 22 transferred to BG
6	Broilers grow out	17 week production	1 on process and 17 transferred to slaughtering house
7	Abattoir	17 egg batches per year	17egg batches per year

On the above table it is clearly indicated that the simulation result almost matches excel data base or real time data.

Generally the above simulation designed as an interactive tool to be used by a planner not as real time decision-making tools, which are directly linked to control system to dispatch tasks. But the simulation will help the human planner to make a right decision by providing information. All in all the simulation helps to understand the overall product chain processes, it uses as a guidance for the planner and it could dramatically minimize the risk of changes in planning process.

4.7 Internal supply chain improvement via production modeling

The main objective of this study is to improve internal supply chain of large scale poultry farms via production modeling. According to the collected data the main factor that affects the farms productivity is their poor and unorganized internal supply chain.

To minimize this problem, poultry farms must work on the key drives of their internal supply chain. And these key drives are facility, information, inventory. Once this gap minimized the farms become competitive in the local & global market and the farms can easily satisfy the demand.

According to the analysis to decide and quantify what facilities are required for the production, what information are required to flow throughout the internal supply chain regarding production, what input materials, products on process, finished products requirement and what transportation vehicles, equipments required for production; poultry farms must have a proper flock projection or planning method.

So the study develop excel flock projection data base and simulation model which allow for analysis of the processes and calculations of effective use of each resource, for ease determining and quantifying the required facility, can communicate horizontally and vertically throughout the internal supply chain and helps to control and manage their inventory.

Generally by using the excel database and simulation model any farm can easily project their production by making small adjustment. But as stated above the flock projection system cannot help the farms unless the internal supply chain parties' work integrated and all facilities are full filled. As stated above according to the master plan of the country it is planned to increase the broiler production by 235% in 2020. This means with the existing large scale farms capacity the country cannot reach the projected production therefore new investments in this sector will be mandatory. This implies the system can also be used for farms with similar configuration that will be established in the future or with small modification if the configuration is different.

CHAPTER FIVE

Conclusion and recommendation

5.1 Conclusion

Ethiopia is one of African countries who have largest chicken population; in the contrary the country has few large scale poultry plants which mean the production in the country is very limited. This is not only because of the limited number of farms in the country but also the inability of these farms to produce to their full capacity. To solve this and other related problems this study focused on increasing productivity by improving internal supply chain of broilers meat processing farms.

As the study identifies, major problems faced by large scale poultry farms are, having poor facilities, poor inventory management and there is an information gap throughout the supply chain. To overcome this problem this study developed an excel flock projection and simulation model, which allows to know the input, work in process and the output (inventory) and this makes the process easier to assign and locate facilities, transportation and also based on this information each responsible parties can communicate throughout the internal supply chain and can control and manage their inventory.

With all departments' commitment to improve internal supply chain to attain the right quantity and quality broiler meat products, it is concluded that the proposed excel data base and arena poultry production model helps to improve productivity of the existing and new large scale poultry plant. If the companies implement the proposed broilers meat process and model, the poultry sector will achieve higher productivity and overall competitiveness.

5.2 Recommendation

Here in Ethiopia in 2014 the government published that there is a good opportunity for the investment of poultry processing plants. It is good to have additional poultry farms but the responsible sector should help the existing farms how to achieve their full capacity and how can they easily supply their product. The ministry of agricultural and other government sectors should work on throughout the supply chain of broiler meat production.

To be productive in poultry farm the breeds have main role and here in Ethiopia there should be poultry breeding and rearing centers which provides improved dual purpose chickens of exotic breeds. As stated above all farms import DOC from other countries which means the country loses lots of foreign exchange in this sector, so the government and responsible sectors should have to work on this area.

In addition by using the developed model as a bench mark and poultry industry can forecast its production or can develop its own flock production. And also by customizing the model it can use for different industries with various production capacities and for egg producing poultry farms.

REFERENCE

1. Indigenous chicken production and marketing systems in Ethiopia: ILRI, Fisseha Moges, Azage Tegegne* and Tadelle Dessie, 2010
2. Feasibility study of an integrated poultry project: MIDROC Ethiopia corporate office research, Marketing department, 2014
3. Central Statistical Agency of Ethiopia, 2014/2015
4. Modes of failure and success in the discourse between system dynamics and discrete event simulation. LSE OR Dept Working Paper LSEOR 00-34, London School of Economics and Political Science, D.C. Lane, 2000.
5. Better poultry value chain development through microfinance in Vietnam; Brussels; September 2009-2010
6. "Supply-chain management: logistics catches up with strategy". Oliver, R. K.; Webber, M. D. ;1982
7. Supply Chain Network Economics: Nagurney, Anna (2006).
8. Supply chain lecture note.
9. Analyzing and improving chicken meat supply chain using beer's VSM, SCOR model and ACKOFF'S circular organization; kowsar darivandi shoushtari, hossein ghasem, mansooreh zarezadeh; Department of Industrial Engineering, University College Of Engineering, University Of Tehran, Tehran, Iran, 2010
10. Measuring Internal Supply Chain Integration; Chuda Basnet; Department of Management Systems; The University of Waikato Private Bag 3105 Hamilton, New Zealand 3216
11. www.intechopen.com
12. The integration within SCM, Emma Toivo, Masters Thesis; 2009
13. Identifying barriers to internal supply chain integration using Systems Thinkin, Franciscus Bakker, University of Groningen, Tillmann Boehme, University of Wollongong, tbohme@uow.edu.au , Dirk Pieter van Donk, University of Groningen; 2012
14. <http://retaileconomics.com/supply-chain-integration> by Joost W. van der Laan, 2010,
15. Internal logistics as a part of supply chain case: Case: nokia- china, dongguang branch; Tian Ran; LAHTI university of applied sciences faculty of business studies international business thesis spring 2009

16. <http://itcon.org/2007/5> A review of approaches to supply chain communications: from manufacturing to construction Published: January 2007
17. Supply Chain Network Design & Optimization Services, Rohit Shukla, About the ITC InfoTech Business Consulting group, 2012
18. Performance measures and metrics in a supply chain environment; A. Gunasekaran, C. Patel and E.Tirtiroglu; International journal of operations and production management, vol 21, no 1, p 71-78; 2001,
19. Supply chain modeling using simulation; Yoon Chang and Harris Makatsoris; institute for manufacturing, university of Cambridge, 2007
20. The Role of Modeling and Simulation in Supply Chain Management1; Caroline Thierry, Gérard Bel, André Thomas; 2010
21. Poultry supply chain: a system approach; Mohammad Shamsuddoha, Mohammed Quaddus, Curtin University, Western Australia;
22. Pre feasibility study, broilers farm, small and medium enterprise development authority government of Pakistan; 2010
23. Reference models for supply chain design and configuration, Markus Rabe Frank-Walter Jaekel, Heiko Weinaug corporate management division, Fraunhofer institute for production systems and design technology, Ipk Pascalstr. 8-9, 10587 Berlin, Germany, 2006
24. A system dynamics model of the chicken meat supply chain faced with bird flu; Thi le Hoa, Daniel Thiel, University of Nantes and e.n.i.t.i.a.a. Nantes, Lem- Largecia; 2007
25. CSA (Central Statistics Authority) Agricultural sample survey report on livestock and livestock characteristics. Addis Ababa, Ethiopia,2011.
26. Overview and Background Paper on Ethiopia's Poultry Sector: Relevance for HPAI Research in Ethiopia; Dawit Alemu, Tamirat Degefe, Setotaw Ferede, Serge Nzietcheung Devesh Roy
27. Poultry sector country review, FAO animal production and health division, Version first December 2008
28. US meat and poultry is widely contaminated with drug-resistant Staph bacteria, study finds; The Translational Genomics Research Institute (April 15, 2011);. Science Daily. Retrieved February 27, 2014.

29. Addis Fortune; 2015
30. <http://www.nationsencyclopedia.com/Africa/Ethiopia-POPULATION.html>
31. Value chain analysis of poultry in Ethiopia; USAID, November 2010
32. <http://www.trademap.org>
33. FAOSTAT, <Http/faostat.fao.org> and international Monetary Fund – 2009 World Economic Outlook
34. Ethiopia livestock master plan, ILRI, August 2015
35. A Comparison of Discrete Event Simulation and System Dynamics for Modeling Healthcare Systems, School of Management University of Southampton, UK, Sally Brailsford and Nicola Hilton
36. Using Computer Simulation to Study Hospital Admission and Discharge Processes, Department of Mechanical and Industrial Engineering of Masters student, University of Massachusetts, Edwin s. Kim, September 2013
37. Using simulation modelling to reduce production losses at DANONE Boksburg, Faculty Of Engineering, Built Environment And InformationTechnology Of University Of Pretoria, Livhuwani Mashavha, October 2011
38. System Dynamics Simulation to Test Operational Policies in the Milk- Cheese Supply Chain. Case Study: Piar Municipality, Bolivar State, Food Quality Engineering Research Group Technical University of Madrid. University of Guayana, Venezuela, Carlos Rodriguez Monroy, Joaquín Fuentes-Pila¹ and Wilfredo Guaita², February, 2008

ANNEX -I

SECTION A: GENERAL INFORMATION

N.B. You can leave any question that you don't want answer

1. Name of organization: _____
2. Location _____
3. Year of establishment : _____
4. Company type: _____
5. What is your designation in the company? _____
6. Experience : <5yrs 5-9yrs 9-12yrs >12yrs
7. Education background:
1-5 6-8 9-10 11-12 10+1-10+3
Diploma Bachelor Degree MSc PhD

B. SUBJECTIVE TYPE QUESTIONS

1. Number of birds processed annually on your farm? _____

2. List the type of product your farm producing?

3. The time taken to produce the product?

Rearing Broilers parents _____

Broilers parents laying _____

Eggs Hatching time _____

To grow the hatched eggs _____

Slaughtering time _____

4. What types of hand and semi manual machine tools are available in your farm?

5. From where do you buy your DOC'S? Why there?

6. Who are your potential customers?

7. is there any complain about your products from your customers? If yes, list them?

8. Is there working together as a team in your farm?

III. Objectives Type Questions

1. Are broiler meat products your main income? Yes No

2. What is your production capacity every year relative to full capacity of the farm (in percentage)? < 50% 50 to 75 % 76 to 90% 100%

3. Is the space of your work place is enough for broiler meat processing? Yes No

4. What type of houses your company builds to process broilers?

- Open
- Closed

5. Does your company uses flock projection? Yes No

6. Does your company implement the flock projection? Yes No

If Yes what percentage _____

7. Where do you get the input sources (DOC)? Local Abroad

8. Are there any problems in obtaining DOC? Yes No

If the answer is yes list some of them-----

9. In what interval does your company import DOC? _____

10. How your company produce its products?

- With customer request
- By assessing the market
- With the availability of raw materials

If there is other specify -----

11. Is there a good market for your products? Yes No

12. Do you get enough information from all departments? Yes No

13. Are there enough facilities to produce chickens? Yes No

14. If No what facilities are missed to have an effective production?

15. Do your farm has any linkage with support institutions? Yes No

If yes, (Tick in the boxes)

Ministry of Agriculture

NGOs

Foreign consultants

Others

16. Have you receive broiler meat processing training before? Yes No

Thank you!

ANNEX -II

FAO classification of poultry production systems Poultry

Sectors definition) (FAO	Poultry production systems			
	Industrial and integrated	Commercial		Village and back yard
		Bio security		
		High	Low	
	Sector 1	Sector 2	Sector 3	Sector 4
Bio security	High	Mod-high	Low	Low
Market out puts	Export and urban	Urban/ rural	Live urban / rural	Rural/urban
Dependence on market for inputs	High	High	High	Low
Dependence on goods roads	High	High	High	Low
Location	Near capital and major cities	Near capital and major cities	Smaller towns and rural areas	Everywhere. Dominates in remote areas
Birds kept	Indoors	Indoors	Indoors. part time outdoors	Out most of the day
Shed	Closed	Closed	Closed / open	Open
Contact with other chickens	None	None	Yes	Yes
Contact with ducks	None	None	Yes	Yes
Contact with other domestic birds	None	None	Yes	Yes
Contact with wild life	None	None	Yes	Yes
Veterinary service	Own veterinarian	Pays for veterinary service	Pays for veterinary service	Irregular, depends on govt. vet service
Source of medicine and vaccine	Market	Market	Market	Government and market
Source of technical information	Company and associates	Sellers of inputs	Seller of inputs	Government extension service

Internal supply chain improvement via production modeling; for large scale poultry farms

Source of finance	Banks and own	Banks and own	Banks and private	Private and banks
Breed of poultry	Commercial	Commercial	Commercial	Native
Food security of owner	High	Ok	Ok	From ok to bad

Sector 1: Industrial integrated system with high level of bio security and birds/products marketed commercially (e.g. farms that are part of an integrated broiler production enterprise with clearly defined and implemented standard operating procedures for bio security).

Sector 2: Commercial poultry production system with moderate to high bio security and birds/products usually marketed commercially (e.g. farms with birds kept indoors continuously; strictly preventing contact with other poultry or wildlife).

Sector 3: Commercial poultry production system with low to minimal bio security and birds/products entering live bird markets (e.g. a caged layer farm with birds in open sheds; a farm with poultry spending time outside the shed; a farm producing chickens and waterfowl).

Sector 4: Village or backyard production with minimal bio security and birds/products consumed locally.

ANNEX -III