

ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY (AAIT)



SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING (SMIE)

(INDUSTRIAL ENGINEERING STREAM)

***Enhancing Performance of Production Planning and Controlling: A Case Of
Hiwot Bottled Water Factory***

By: Tassew Nigussie

GSE 5918/09

**A MASTERS THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES OF ADDIS
ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
DEGREE OF MASTERS OF SCIENCE IN INDUSTRIAL ENGINEERING STREAM**

Main Advisor: Dr. Kassu Jilcha

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DECLARATION

I hereby declare that the work which is being presented in this entitled “**enhancing the performance of production planning and controlling**; with special reference to Hiwot water factory ”is original work of my own, has not been presented for degree of any other university and all there source of material used for this have been acknowledged.

Tassew Nigussie

Date

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

Dr. Kassu jilcha
(Thesis Advisor)

Date

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Before and above all. “let GOD the almighty be praised for making me healthy and happy to carry out this these is first, my grateful thank goes to my advisor Dr.Kassu Jilcha for his unreserved support and encouragement while doing the thesis. He helped me to acquire lots of knowledge and skills during my stay at Addis Ababa University.

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Abstract

The purpose of this study is an attempt to identify the problems of production planning and controlling performance in Hiwot bottled water. Additionally, to study the effective utilization of resources and not accurate planning analysis, coexist in the company. To conduct this research-intensive literature survey was carried out. With regards to the research, questionnaires were developed; general information production planning and controlling, material requirement planning, demand forecasting, lead time, inventory control, scheduling accuracy, production planning tracking are key performance indicators are selected for analysis. The questioner (research tools) was distributed to 11 staff which are directly involved in production planning and controlling activity and all questionnaires filled. Then, the collected data were analyzed using IBM SPSS 20.0; in both descriptive (mean and standard deviation and inferential statistics (correlation and regression). In addition to these the optimizations analysis are done using Goal programming with POM-QM software and got an optimal solution for throughout a year and analyzed basic utilization of resource (production time, cost, warehouse capacity, inventory, labour).

Finding values: Regarding the correlation analysis, it is possible to conclude that there is strong and positive relationship among the key performance indicators of production planning and controlling are material resource planning, manufacturing resource planning, lead time, scheduling accuracy, capacity planning, production planning tracking and correlation analysis indicates statistically significant of 0.53, 0.693, 0.667, 0.731, 0.747, 0.630 and the optimal result For the first quarter deviational variable; d_1^+ to d_{12}^+ are equal to zero so that the objective four can be attained in January, February, March, but cannot attain in this period from January to march deviational from d_{24}^+ , d_{25}^+ , d_{26}^+ and d_{27}^+ are 0, 0, 1530438, 1878087 respectively, the value $d_{25}^+=1530438$, $d_{26}^+=1878087$. For the second quarter the analysis showed that the production costs in these time intervals are underutilized. Between July to September the production costs reduced and the resource in these time intervals are underutilized. The percentage utilization in two consecutive months are 9.49%, 11.3%. The warehouse capacity will be under capacity during the first quarter to fourth quarter year.

Finally, the study develops a model and recommended the factory to have a proper production planning and control with better utilization of resource in order to enhance production planning.

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LIST OF ACRONYMS

PPC-Production Planning and Control

E.C-Ethiopian Calendar

MRP-Material Requirement Planning

SA-Scheduling Accuracy

PPT (PT)- Production Planning Tracking

CT-Capacity Planning

IC-Inventory Control

HDPE-High Density Poly Ethylene

CSA-Central Statistics Agency

KPI -Key Performance Indicators

SPSS - Statistical Package for the Social Sciences

POM= Production Operation Management

ISO= International Organization for Standardization

CHAPTER ONE

1. Introduction

Production planning is one of the most significant roles in the process of operation and production management. In production planning, executive of manufacturing sectors require to make essential decisions on which accurate aggregate levels of production, stock, and employees have to be produced to meet likely demands (Radet., al, 2014).so that mainly firms are using this planning system together with controlling mechanisms. Production planning and control are mainly concerned with applying the plans, the comprehensive scheduling of jobs, allocating workloads to machines (and people), and the actual flow of work through the system (Deepak Sharma.et., al 2014). According to Albina, (2017) it is a complex process, and such as that involves a large number of elements that have to be integrated and that is not an easy task. A little imprecise step can cause the entire process to go into the wrong operation.

In today's business environment, technology development, and speed of industrial change minute counts any loss of the entire business. The company must have a dynamic and flexible system for production planning and control which gives to the rapid changer and reduced higher amounts of loss. Execution of action required in the production and control process needs to understand the customer need, identification of which product is seasonally high customer demand, which product is consumed throughout the year by taking consideration of quality, time, terms of delivery as means of labor, work and knowledge. The main constraint and limitation is the production facilities the production resource available in the market like material, production. Ultimately the time comes for a building plan that will combine the assortment and its qualities with the production sit, time, and demand for the resource.

According to Jonson,Matson (2003) production plan constraint from the production plans integrates the operation strategies sales and operation planning, quality, material requirement planning(MRP), master production schedule (MPS), and operation planning but the other concepts like capacity planning, resource requirement planning(RRP), capacity requirement planning (CRP), rough-cut capacity planning (RCCP) should be included in the planning process.

Most of the studies concentrated on enhancing the effectiveness of production planning and control only production-related concept like controlling resource (material, labor, machine, time) but it must have also included the integration planning within the company and the forecasting techniques which can satisfy the marketing demand within the company. The planning system also integrates from the top to floor production huaraches to get the better results. Ethiopian bottled water producer is increased now a day because of this the market comparative is high. To make the company competent and getting better market share, the production planning is much better than the other.

Hiwot bottled water started production 5 years ago. During that time the competitor is very small compared to the current time so that enhance the effectiveness of this production planning and control is a means of market competitive, decision-making, and problem-solving perspectives for the organization. this study focuses on the current production system has its production planning and control but these should enhance the efficiency by considering the necessary input like material requirement planning, capacity requirements paining, master production schedule, resource requirement planning, maintenance planning, and integrating all resources and getting better production planning and control. The introductory parts that narrate about the production planning and control .in addition to the case company information but the studies do not n narrate production planning and control implementation on the case company. The theoretical investigation followed in the literature reviewed depicts that the methods in gathering information. Therefore, filling the gap exist in many types of research organization, workers, as the whole country will be benefited from this research in the private bottled water sector. the challenge of this production planning and control will be intensively explored and reductions of many productions lead time.

1.1 Background and Problem Justification

Water in a plastic bottle cannot be the most exciting product category, but sales of bottled water have registered nearly continuous growth for more than three decades. The idea of bottling water began in Europe in the 1700s, when mineral spring water was bottled and sold for its reputed healing properties (Michael, 2013).

According to European Federation of bottled water (2010), the bottling of water is many hundreds of years old, the first modern bottled purified water factory was started in America in1845 by Ricker family, the grounded raw water is got from the different unknown source.

These small firms are rapidly growing, uses springs to make up the medical feature. Finally organized Poland Spring Water Company.

According to Global Bottled Water Market - growth, trends, and forecast report in 2018, stated that the bottled water industry was valued at US\$ 185 billion in 2015 and is expected to reach US\$ 334 billion by 2023. The demand for bottled water has been growing during the last decade, The consumption of bottled water also increased rapidly in households primarily. The number of consumers is continuing to grow in Africa, Asia, Latin America because of rapid population growth and less access to clean tap water.

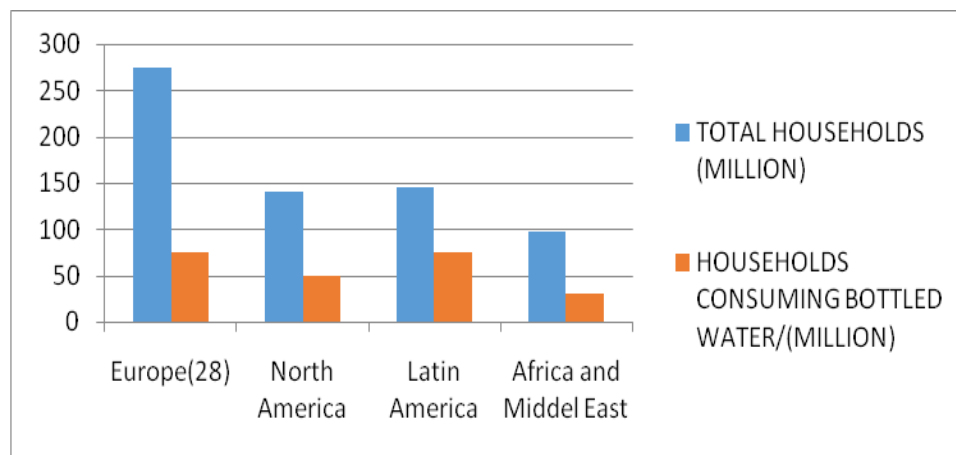


Figure 1 Consumption of bottled water (Global Bottled Water Market - growth, trends, report in 2018)

N.B. Excel households drinking sparkling water for taste and Based on World Bank data assuming 7 people per household; 24% in sub-Saharan Africa; 76% in North Africa and Middle east. A decade ago, the idea of bottled water for many Ethiopians was a development that characterized the Diaspora and the modern, wealth-driven way of life. Today, it is familiar to see people obtain bottled water along with their groceries in supermarkets and kiosks. Many people consumed bottled water in hotels, bars, cafés, and restaurants. In some offices, bottled water also has become one more option in addition to the “tea or coffee” offered by secretaries to visitors. Bottled water has mainly available at meetings, conferences, and discussion forums. Urbanites from many different walks of life have made it part of on a daily basis consumption. The study of Central Statistics Agency (CSA) 2010/11 shows, about 51 soft drinks and bottled water producing factories have been prepared with a registered currently capital of ETB1,106,223,000.

Their actual production capacity has reached more than 1.3 million hectoliters and the gross value of production has agreed ETB3.6 billion in the same survey period. According to the similar source, the sector has created approximately 8,000 jobs.

There are many reasons for this fast growth. The wide-ranging economic development the country has been registering in the past last decade is just one reason. Though this growth is accompanied by unprecedented inflation, the income of the urban population has also shown tremendous growth. According to the report of MoFED's (2012/13) on the base economic performance/capital income of Ethiopians has reached USD550 from a merely USD100 a decade ago.

A lot of factors, such as the increasing number of conferences and summits in Addis Ababa, the increased tourist traffic, and the development of the hospitality sector have contributed to this expansion. This can be identifiable how simply seen in the growth of the number of soft drinks and bottled water producing factories from 13 in 2006/7 to 53 in 2010/11. Moreover, according to sources at the Ministry of Industry, a number of other companies are in the pipeline to join the industry (Ethiopian business review, 2013).

According to Addis Fortune Business Indicator (2014), now after roughly a decade of development, it is not so special to see several alternatives in Addis Ababa. Other cities to have their own brands, bottled from in close proximity sources. Though it is difficult to obviously identify the most consistent data, different agencies propose that anything from 26 to 60 brands has now entered the market place Up until 2013, the figure had reached 53, and if the similar progression continues it will continue to rise by 13pcs per annum, reaching approximately 90 by 2020. The number of consumers has escalated over the years; to a point where some have stopped drinking tap water altogether.

Production systems organize equipment, process, and information to manufacture or produce the desired products for the customer by using production planning and control mechanism .so that enhanced integration to increase productivity with minimized operating costs and other costs can be attained by effective production planning and control.

Production systems organize equipment, process, and information to manufacture or produce the desired products for the customer by using production planning and control mechanisms. So that enhanced integration to increase productivity with minimized operating costs and other costs can be attained by effective production planning and control.

Optimize and control the production planning in order to enhance the performance delivery on-time, decreasing inventory, minimizing extra production hours, making inventory safe, and so on. The executives can be set which should be done primarily through load coefficient to select or unrestraint purposes of the organization. Also, the executives can determine the load coefficients of different aims according to the exciting situation or can make judgments' by using the entire objectives. Optimize the production planning and control, resource requirements planning, inventory resource planning, raw material requirements planning, production machine requirement planning, and extra working hours' production requirement planning. It can resolve the difficulties that plans are splitting from one another and the integration wants proper response in the previous ERP structure Wang et.al. (2014)

Most available research shows the production planning and control system are the main roles in manufacturing industries. PPC applications are different in the application area we use in addition to this. The previous researches show that PPC is used to control different kinds waste but the most available researcher does not include many parameters of that are use full in the application of PPC like forecasting technique, optimization sequence, and integration of different parameter in order to enhance the effectiveness of PPC this is the major resource gap. The industries must consider all the basic input of any PPC in order to get better profit and also makes the company more competent to others.

Ethiopian bottled water manufacturing company is computation is high so that a good production planning and control factory are more competent camper to the improper production planning and control. Hiwot bottled factory is one of the manufacturers of bottled water but currently, the production is less compared to the maximum production capacity of factory and less delivery time compared to other and also loss the market shear due to lack of proper PPC. According to 2018 production report stated that production capacity of the factory is 12,000 bottled per hour but actually produced item is with 7000 bottled per hour so that it is better enhancing the productivity by the help of effective production planning and control and also more amount of

demand are not satisfied because only company trucks are can take all the daily product. So this recherche are needed to enhancing productivity and satisfy customer demand.

Hiwot bottled water factory is produced four types of products in the three-shift arrangement by using high technology like Nano filter and revise osmosis. This production planning and controlling mechanism do not satisfy customer demand as compared to the company production facility. So that better production planning and control mechanisms are needed to achieve the customer demand and reduced production lead time and reduced production wastage like material, labor, and machine. This study focused on the production of bottled water in this factories needs improvement on production planning and how the production controlling mechanism are helpful to a minimum cost of production and to handle different kinds of customer demand .during this study the methodologies are the observation of production facilities or production department which are directly related to the production, preparing semi-structured questioner which is important to analyzes for product forecasting, sample determination from the given company product, sample selection, using different Production and maintenance report as well as quality control document analysis with the help of MS Excel, production operation management software, SPSS, and other tools for the preparation of material requirement planning and master production schedule with the integration of maintenance schedule finally prepared production planning and controlling mechanism of the production. The benefit of this is the company can reduce different resources, time, and getting better profit and enhance customer satisfaction.

1.2. Problem Statement

Hiwot bottled water factory produced different kinds of products but as it motioned in the above Ethiopian factories, there are problems on the luck of good production planning and controlling on the existing situation, According to Hiwot Bottled water, 2010/2011 E.C production reports show that the company uses 63.25% of its useful capacity and the efficiency of planned quantity compare to the actual production about an average of 67.33% of three major company's product. According to Margret (2016) stated the production planning effectiveness based on ISO 22400 standard scheduling KPI measuring elements by considering planned runtime per item, produced quantity, actual production time is about 53.2% in 2010 and 58.4% in 2011 half-year report. In addition to this marketing survey of 2009 reports presented by the sales and marketing

department stated that there is a high level of customer demand but the company satisfies about 37.8% (55,938,024.58 /piece) of quantity per year on average for one kind of product.

Research questions are

1. What are the key performances that can affects production planning and control in Hiwot Bottled Water Company?
2. How to analyze the relationships among key performance indicators?
3. How to computing optimal solution and preparing for production planning and control in Hiwot Bottled company?
4. How to develop production planning and control optimization model?

1.2.1. General objective

The study is enhancing the performance of production planning and control in Hiwot water and develops production planning and control that manages customer demand.

1.2.2. Specific objective

The specific objective of this research

- ❖ To identify key performance indicators that affect production planning and control.
- ❖ To analyze the relationships of key performance indicators.
- ❖ To computing the optimal solution for production planning and control.
- ❖ To propose a model of production planning and control.

1.3. Scope of the study

The scope of the study is a production planning and control of Hiwot bottled factory of performance using a two-year production history of different products and as per identified problems, research questions, and objectives. Accordingly, the research used SPSS tool to do descriptive analysis correlation and regressions analysis, However, this research does not include the quality of the product, performance of the employer.

1.3.1. Significance of the study

The research significance will be a startup for other researchers in Ethiopia food processing and a bottled water factory as data sources. The other important thing is used to control major production resources within the production floor; the company can reduce the higher amount of expense due to improper management of raw material, labor, and machine production time. This

study also provides a large amount of quantity throughout a year by satisfying the customer demand without changing any production facility like layout; machines and enhancing the profit besides this reduce the cost of production getting a competitive advantage to the company. This company can reduce maintenance overhead costs by implementing this effective production planning and control mechanism, machines are serviced timely and use proper production process flow and also can reduce maintenance personnel work fatigue.

1.3.2. Organization of the paper

The thesis has seven chapters. The first chapter is about the introduction of the study. It contains the background of the study, statement of the problem, the significance of the study, and the scope of the study. The second chapter is a literature review from different sources on the concept of production planning and controlling in strategies and different forecasting concepts and its application and drawback. The third chapter is the research methodology. In this chapter Data collection and presentation methods, data analysis tools, sampling, sampling techniques, and methodology framework presented in detail. The fourth chapter is the company profile. Company vision, mission core value, and organizational structure included. The fifth chapter is data collection, presentation, and analysis. The primary data collected from the different sources through observation, interviews, and questionnaires properly integrated and presented in a descriptive manner as per the objective of the study. Data analyzed with the help of forecasting and aggregate production scheduling analysis. The sixth chapter will be developing of production planning model for the case company. The seventh chapter is a conclusion and recommendation.

CHAPTER TWO

2. Literature Review

2.1. Introduction

Production is a process or method to convert different types like material, labor, capital, energy, and information to a particular output (product) and service with desired quality and quantity. The production system contains sequential operations to produce specific items/service/ suitable to the customer and that can meet the customer demand in quality and anticipated function.

Planning and control are the two main components of the management process aspect. it is a tool that integrates the whole manufacturing tasks in a production system. This production planning begins with the analysis of the current production given data (demand forecasting for the product, delivery time, etc.) and the information accessible, schedule for utilization of the company resources like material, machine, men are work out to get the goal in a cost-effective way. once the schedule is prepared, then the operation is done in sequence within the main production plan. Production control takes part in action if there is a difference between the planned quantity and actually produced items. The corrective action is done if there is deviation so that different controlling techniques are used to achieve the target.

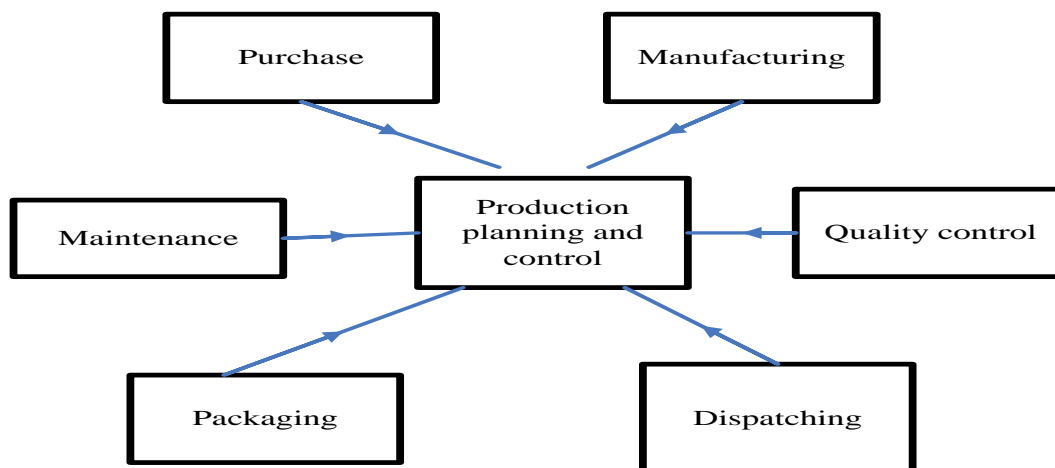


Figure 2 Production planning and control(Collins and Wright 2013)

According to “Production planning and control is compared to the nervous system in the human body. This is because just as the nervous system regulates muscular movements in the human body; in the same way PPC coordinates all the activities of the plant”(Collins and Wright 2014).

2.2. History of Production Planning and Control

2.2.1. Production Planning and Control Globally

Production planning and control have gone through a lot of changes in the last 30 years. Before 1960 inventories were manually controlled system and different tools and techniques, stock refill, according to (Brian et...al 2010)(Durmusoglu et al.,1996) express that by the middle of the 1970s, enough understanding of material requirement planning(MRS) by this methods had been got many benefits. the significance of the master production schedule (MPS) was considered material availability was not only one difficulty that would affect the production schedule. (Brian et..al 2010)(Millard,1985) and it was this problem guide to anticipated MRP by its self not enough control production system with closed loop.MRP obviously being articulate as the sum of MRP and capacity planning facility. According to (Brian et..al 2010)(Milard,1985) correctly state that development improvement of MRP II, taking into consideration an economic point of view in a similar fashion that closed-loop MRP systems are being expressed (Brian et..al 2010)(Durmusoglu et al.,1996).

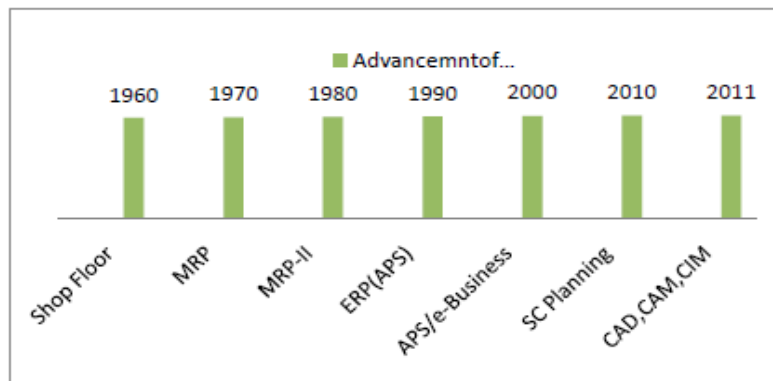


Figure 3 The Development of Production Planning and Control Systems (Alie& Daniel, 2017)

The figure clearly shows that then information and communication technologies (ICT) have helped the continuing development of computer-based systems for PPC. Thus, current advanced PPC systems considerably use advanced computerized systems and programs. This is very much interlinked with the actuality that manufacturing has been simplified with Computer-Aided Manufacturing (CIM) systems(AlieWube, 2017) (D. Kitaw, 2014).

2.3. Definition of Terms

Planning is the process of selecting and sequencing activities such that they achieve one or more goals and satisfy a set of domain constraints. It looks ahead, anticipates possible difficulties, and decides in advance as to how the production, best, be carried out (Alieet., al 2017).

Control: phase makes sure that the programmed production is constantly maintained.

System: is a function is to convert a set of inputs into a set of desired outputs.

Production control (PC) is the function of management which plans, directs and controls the material supply and processing activities in an enterprise (Alie et..., al,2017).

Production Planning is done before any production activity. It is plans used for arranging desired production facilities are determined. It focuses on the basic concept of what items to be produced when the part is to be produced, how much numbers to produce, and consider overall production in long term (Ramachandran, et...al, 2016).

According to (Surana,& Ghaziabad, 2014) state that Process planning; the definition of each operation of given components part, different subassembly assembling is to manufacture the product in a given layout for the movement of many manufacturing inputs through the entire factory. Manufacturing systems are easily controlled by using production planning and controls are done through four basic phases. These are process planning, loading, scheduling, dispatching (Jaipur, 2013).

Production Scheduling deals with the well-organized allocation of tasks over resources. The general scheduling problems, given a number of tasks and amount of resources, time setting when each task should be accomplished on every resource. Since, production scheduling is to manage the process that is used in manufacturing and service industries to attain efficiency and reduces production cost (Alie & Daniel, 2017).

Production planning and control are organization processes that are strongly linked to different departments, peoples to ensure that businesses should run through challenges turning raw material into the actual product with efficient and cost-effective use of time(Leslie bloom, 2018). According to (Deepak Sharma, et...al 2014) the production planning and control has different types of objective the first one is nature of inputs are used. The quality of the product depends

upon the nature of the inputs are consumed. Hence, the planning is done to find out the nature of different kinds of inputs which is an intricate process. The second is the Number of Inputs which means to attain a level of production, determination of the quantity of the inputs and their composition is very significant. A product can be prepared only when there is to calculate approximately the required composition of inputs. The third one is Proper Coordination; It ensures the proper coordination between the workforce, machines, and equipment. These lead to a reduction of wastage and a smooth flow of production. The fourth Better Control in production planning is the method of control. For better control, planning is a requirement. Only then, one can evaluate the performance and calculate the difference which leads control of the production. Five is Ensure Uninterrupted Production the planning of materials make sure the regular supply of raw materials and other components. The regular flow of materials and supplies is helpful in continuous production. Sixth is Capacity Utilization there is a requirement to use the existing resources effectively. It is helpful in bringing down a variety of costs of production. Finally, Timely Delivered If there are good production planning and control, there will be timely production and the finished product will be rushed to the market in time. This also ensures a better relationship with customers.

2.4. Aggregate and objective production planning (APP)

Aggregate production planning (APP) is a medium-range production and employment planning that normally spans a time horizon which ranges from 3 to 18 months and is about determining the optimum production quantities, hiring and layoff rates, workforce and inventory levels, back-ordering and subcontracting volumes, and so on for each time period within the planning horizon subject to the limitations of available production resources (Jamalnia, 2019).

2.4.1. Advantage and Objective of Production Planning and Control

According to (Ramachandran, et...al, 2016) Industries must be organized production activities and effective utilization of Production resources of the factories to increase productivity. Production planning and controls can take tools used to coordinate and integrate the entire activities of the given production system. need to attain effective utilization of production resource, to achieve the production goals based on quality, quantity, cost and timeliness of delivery, used to reduce inventory holding cost, to get better, continuous production flow in order to archive customer demand, with proper considerations of quality and committed of delivery time, to reduce idle time of machine and manpower. in addition to this (Leslie Bloom,

2018) argues that PPC is used to keep the team in an organized way. Some use is improved communication means interrelation between people and departments is communicate through printed schedules, regular meetings, printed schedules meetings or electronic online management systems protect the whole production team trained and on the given process. If there are failed communications between the teams it goes to confusion. Another one is if the product to be better and successful in each production process in must have to create good quality control within production planning and control so that it can check the product quality within the testing limit or standard. Finally, production planning's needs for morale boost Employees are more likely to enjoy by finish your task and consider yourself as important and have a significant part on the team this leads to happier in each production process. When the entire manufacturing process works smoothly without any difficulties. The smooth production planning and control mean the companies are organized, meet the customer delivery time. These leads to getting more sales, profits, and high customer satisfaction.

According to (Leslie, 2018) production planning can be affected by the following are demands that are varied on different season PPC should consider all these activities on the base of input and outputs, Test marketing, insistent marketing strategies for a new emerging product are to be sold in for knowing the trend. Mostly it is not large-cycle operation, irregular in nature, and can affect production, after-sales service; this is essential for business success. But the drawback of this service is returned items for repair, unscheduled rework process this leads to overload on the production line, Losses due to catastrophic error/failure occur due to fire, labor accidents, loss of production input, material, components. Because of this planned production schedule are affected in time as well as quantity, Losses due to predictable factor; losses are the material loss of production system production loss and variation of material consumption and the chance of failure, Production of order; due to customer pressure the previous production order are changed so that all the production line is loaded, research and development are changes the design of the product so that all the production planning and control are affected due to this change.

2.4.2. How to Make Production Planning?

The production plan gives a foundation to any kind of actual work schedule and plans the daily activity. If there is high customer demand, it will be prioritizing and addressed individually. These orders are determining workflow and all the necessary steps and also used to evaluate

production readiness. Line planning; it is scheduling and allocating of the resource through production lines based on product setting and production due date.

Line plan used to define raw material is can be loaded to the production paths, numbers of the product are expected from the given production line, and when the order is finished. The benefit of line planning; it assists production managers and supervisors with important information such as daily production targets. The production facility like man and machine accordingly. Planning tools; some planning tools are listed are a planning working board uses excel sheet or printed format, time and action calendar (order wise) time and action calendar format for production merchant, time, and action plan calendar plan sheet paper.

2.4.3. Common Aggregate Planning Strategies

Chase Strategy is a strategy to produce quantities of goods in accordance with the demand to forecast for that month. Firm's it has to be producing the right number of quantities of product in on top of the customer request through the normal production scheduling, sub-contracted, and overtime production. This strategy meets production levels and the requirements in the period of the strategy. Inventory maintenance cost does not determine in this strategy. Level Strategy is a strategy that steadiness the level of production in the whole production planning period. The company must attain a level of production with the usual production, overtime, and subcontracting. In this strategy subcontracting costs and minimum cost inventory shortage, but has cost storage handlers in production activities. Mixed Strategy goals are to produce output on the base of production capacity of normal time, subcontracting, and overtime optimally so as to achieve the demands of every month. This strategy seeks out to keep away from the shortage of inventory when it happens can lead the customer to lose and disappointment. Mixed Strategy calculated using the method of transportation to find the optimal solution (Noegraheniet., al, 2016).

2.4.4. Classification Schemes for APP Models

In this section, a comprehensive classification scheme is presented, which categorizes the APP models into different structural groups based on the level of uncertainty that exists in the APP model. The input data for APP models can vary from deterministic to stochastic and fuzzy sets. Another important criterion that affects the structure of the APP model is the number of objective functions that a model contains. Based on these two criteria the structure of the APP model could be categorized into six main structural groups.

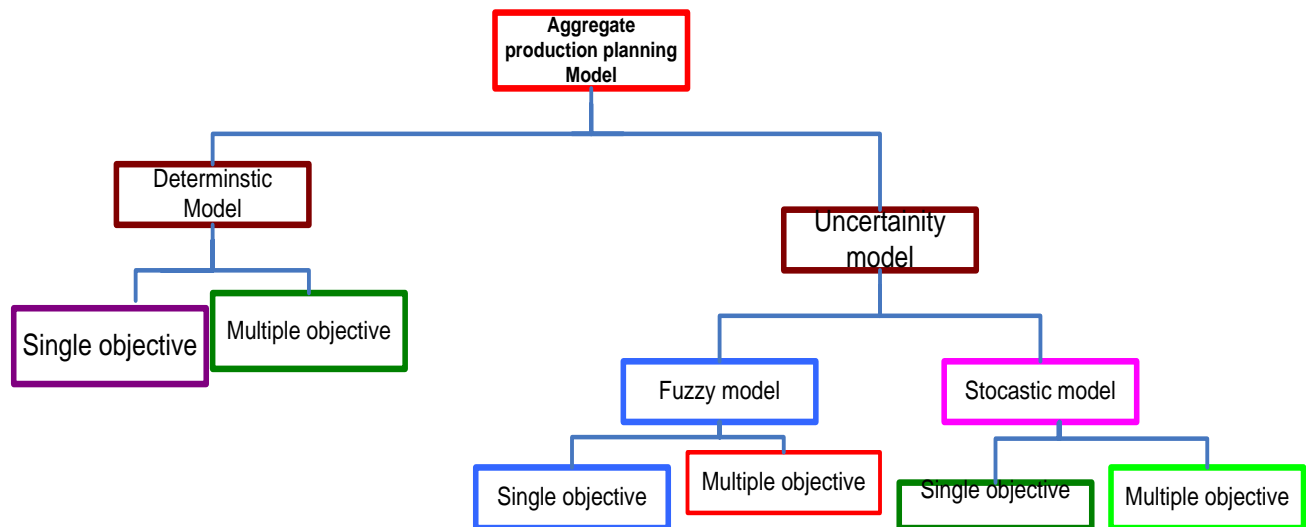


Figure 4 Structural groups for AAP model (Cheraghalikhani, 2019)

Deterministic Models; Any APP model includes several parameters such as market demand, production costs, inventory costs, labor costs, subcontracting costs, production rate, backorder cost, subcontracting restriction, product capacity, product sales revenue, maximum labor level, maximum capital level, etc. These parameters are used in objective functions and constraints of the APP models. In deterministic models, all of these parameters are assumed to be known prior to planning. Deterministic models are divided into two subdivisions including single objective and multiple objective models. In real-world situations, APP problems normally involve multiple, conflicting, and incommensurable imprecise objective functions (Cheraghalikhani, 2019) (Liang, 2007).

Uncertain Models (Cheraghalikhani,2019)Galbraith (2007) defines uncertainty as to the difference between the amount of information required to perform a task and the amount of information already possessed. In the real world, there are many forms of uncertainty that affect

production processes. Categorizes them into two groups: (I) environmental uncertainty and (II) system uncertainty. In real-world APP problems, the input data or parameters, such as demand, resources, costs, and objective function coefficients are imprecise in nature, because some information is incomplete or unobtainable.

Fuzzy Models: Fuzzy sets theory is very appropriate for the industry with such ill-defined conditions in APP models. Some types of uncertainties, e.g., fuzzy demands, production capacities with tolerance, inexact process time, etc. are usually encountered in the APP of manufacturing systems. It is unsuitable to describe these types of uncertainties by the frequency-based probability distribution

Stochastic Models: The stochastic models and methods are usually based on the concept of randomness and probability theory, and they are limited to tackling uncertainties with probability distributions (Tang et al., 2003). Some researchers have concerned about single objective stochastic APP models (Leung et al., 2006; Ganesh & Amoorthy, 2005; Wang & Liang, 2005; Hsieh & Wu, 2000; Leung & Wu, 2004; Leung et al., 2007).

2.5. Forecasting

Forecasting is a method or a technique for estimating future aspects of a business and important for short-term and long-term decisions (Gahirwal, 2016). It is the process of making statements about actions whose actual finish (typically) has not yet been observed. An ordinary example might be an assessment of some variable of interest in some specified future date. Prediction is similar, but the more general term (Eelier et., al,2014). The goal of any forecast, what constitutes an efficient forecast, is to be accurate, timely, and cost-effective. The forecast is accurate if it has a small error, but also if it is well-calibrated and has an out-of-sample validity i.e., it predicts the future rather than describing the past (Deepak, et...al, 2015).

2.5.1. Time series methods

Time series method is the most used forecasting methodology in the literature. This methodology uses past sales data to predict future demand. In most cases, past sales data of a product can be divided into six components: the average amount of sales for that period, a trend, seasonal element, cyclical elements, random variations, and autocorrelation (Demir & Akkaş, 2018).

2.5.2. Moving averages (MA)

Moving averages (MA) is the simplest but very popular forecasting method. When the past sales values of a product have not seasonal behavior and the related data is neither growing nor

declining rapidly moving averages can be useful for predicting future sales. A moving average is defined as the arithmetic average of the most recent observations as follows (Demir&Akkaş, 2018) (Nahmias S., 2005)

$$FT = (D_{t-1} + D_{t-2} + \dots + D_{t-N}) / N$$

2.5.3. Exponential smoothing (ES)

The major drawback of the moving average method is the need to continually carry a large amount of historical data. In many applications, the most recent occurrences are more indicative of the future than those in the more distant past. In these cases, exponential smoothing (ES) is the most logical and easiest method to use and the formulation of simple exponential smoothing is given as follows.

$$F_t = \alpha D_{t-1} + (1 - \alpha) F_{t-1} \text{ where } \alpha \leq 1 \text{ is the smoothing constant.}$$

2.5.4. Holt's linear method (HLM)

Holt extended the simple exponential smoothing method to allow forecasting of data with trends. This method uses the following three equations with two smoothing constants

$$S_t = \beta(S_t - S_{t-1}) + (1 - \beta)G_{t-1}$$

$$F_t = S_t + G_t$$

Where S_t denotes the level and G_t denotes the slope of the series at the time, respectively.

2.5.5. Winters's method (WM)

Winters's method is also an exponential smoothing method having three smoothing constants and it considers seasonality in the series. The advantage of this method is that it can be easily updated as new data become available. Three exponential smoothing equations are used each period to update estimates of depersonalized series, the seasonal factors, and the trend. These equations have different smoothing constants labeled as α , β , and γ ($0 < \gamma \leq 1$)

The current level of the depersonalized series, S_t is given by

$$S_t = \alpha(D_t / C_t - 1) + (1 - \alpha)(S_{t-1} + G_{t-1})$$

The trend is updated in a similar manner as in Holt's linear method:

$$G_t = \beta [S_t - S_{t-1}] + (1 - \beta)G_{t-1}$$

Finally, the seasonal factors are computed as follows:

$$C_t = \gamma (Dt/St) + (1 - \gamma)C_{t-N}$$

Here $C_{t=N}$ is the multiplicative seasonal component in period t , where $\sum C_{t=N}$ Using these equations the forecast in period t can be made by the following equation:

$$F_{t+1} = (S_t + G_t) C_{t+1-N}$$

For demand forecasting, the performance measures to take part in a serious function. Most of the studies calculate the forecasting performance by means of mean squared error (MSE), mean absolute percentage error (MAPE) & mean absolute error (MAE) (Shuyun, 2019)

Decomposition of Time Series

A time series can be broken down into its components. The decomposition of time series is a statistical method that breaks a time series down into its components (Trend, Seasonal, Cyclical, and Random /Irregular) Decomposition methods usually try to identify two separate components of the basic underlying pattern that tend to characterize economics and business series. The trend Cycle represents long term changes in the level of series. The Seasonal factor is the periodic fluctuations of constant length that are usually caused by known factors such as rainfall, the month of the year, temperature, the timing of the Holidays, etc. Any time series is a composition of many individual underlying component time series. Some of these components are predictable whereas other components may be almost random which can be difficult to predict.

Decomposing a series into such components enables us to analyze the behavior of each component and this can help to improve the accuracy of the final forecast. A typical sales time series can be considered to be a combination of four components i.e. trend component (T), cyclic component (C), seasonal component (S), and an irregular component (I).

a. Decomposition Models :

Mathematical representation of the decomposition approach is:

$$D_t = (S_t, T_t, IC_t) \quad \text{Where,}$$

D_t is the time series value (actual data) at period t.

S_t is the seasonal component (index) at period t.

T_t is the trend cycle component at period t.

IC_t is the irregular (remainder) component at period t.

The Seasonal component models patterns of change in a time series within a year. These patterns relate to periodic fluctuations of constant length tend to repeat themselves each year. The Trend represents changes in the level of the series. The Cyclic component refers to patterns, or waves, in the data that are repeated after approximately equal intervals with approximately equal intensity, with period normally larger than the seasonal period. Usually, the trend and cyclic component are together treated as the Trend component. The Irregular component refers to variations not covered by the above. (Residuals) The mathematical representation for decomposition is

Trend (T)

$$(D_1 + D_2 + \dots + D_{12}) / 12 \text{ for } t = 1 \text{ to } 12$$

$$T_t = (D_{t-11} + D_{t-10} + \dots + D_{t-1} + D_t) / 12 \text{ for } t > 12$$

Seasonality (S)

$$DT_t = D_t / T_t$$

$$S_t = \text{Average } (DT_t, DT_{t-12}, DT_{t-24}, \dots, DT_{t-k}) \text{ till } t - k > 0$$

Irregular Component (IC)

$$IC_t = D_t / S_t$$

Forecasts of the individual components can be combined to get the final forecast by using operator '+' and 'x' so there are two models shown below, the decomposition could be additive if the magnitude of seasonal fluctuations does not vary with the level of the series.

$$D_t = T_t \times S_t \times I_t \text{ ----- Multiplicative model}$$

We have a multiplicative decomposition if seasonality fluctuates and increases and decreases with the level of the Series.

$$D_t = T_t + S_t + I_t \text{ ----- Additive model}$$

Multiplicative model is more prevalent with economic series since most seasonal economic series have seasonal variation which increases with the level of the series. Further experiments carried out on a sample set of sales.

2.5.6. Inventory Control Techniques

The right approach to inventory control utilizing the modern inventory control processes and the new and more refined techniques can provide for a dynamic optimization of inventories to maximize customer service with decreased inventory and at lower costs. The inventory stocks are usually maintained using two systems (Francis and DE Souza, 2004). Periodic/Cyclic System; the stocks are reviewed at periodic/fixed intervals. Thus, the ordering interval is fixed, but the ordered quantity is varied. The orders are placed depending on the stock in hand and the rate of consumption. Two-bin System; It is a perpetual inventory system where each item stock is held in two bins. A larger bin, containing sufficient stock for the time interval between the arrival of an ordered stock and the placement of the next order, and the other bin containing stocks large enough to satisfy probable demands during the period of replenishment. When the primary storage bin is empty, the order for the substitute is located, and the stock in the second storage bin is utilized until the ordered material is received. This system can work well for low consumption value items. As resources are limited, the existing resources must be appropriately utilized taking into account the overall market competitiveness, and the attainment of the highest level of customer service delivery ICT's have been developed so that they can favorably impact the profits of an organization. Thus, it becomes imperative for health managers to use scientific methods for maximizing their returns from investments made at a minimal cost (Devnani et al., 2010) (Ramanathan, 2006).

2.6. Production Control Functions

According to Deepak Sharma, 2014 stated that dispatching is the part of production control that interprets the paperwork into actual production in accordance with the particulars job under routing and scheduling functions. This deals with setting the manufacturing task in motion through the release of orders and orders by the earlier planned timings as embodied in production schedules. Expediting/ Follow-up/ Progressing makes certain that, the work is accepted out as per the plan and delivery schedules are met. Follow-up different tasks such as reporting, presence

to bottlenecks or holdups in production eliminating the same, controlling difference or difference from planned performance rank, following up and monitoring the development of work through all stages of production, organize with purchase, stores, tool room, and maintenance section and changing the production plans and re-plan if essential. Inspection is checking or measuring for verification of quality and quantity of the product in any of its characteristics. It is an important tool for ascertaining and controlling the quality of a product. Inspection is an assessment of different tasks that evaluate goods or services to a standard.

2.7. Literature Summery

2.7.1. Literature review methodology

This research tries to search for many references based on the concept of production planning and controlling related using a different web site like Google scholar, Scopus, Science direct, and different research thesis papers. From this resource, it tries to refer 121 articles and journal which are directly related to this concept.

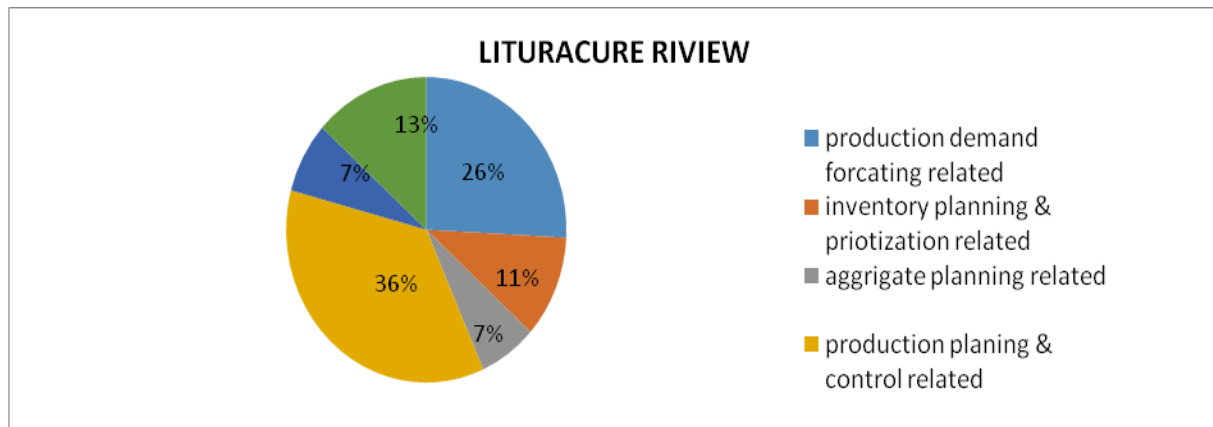


Figure 5 Literature review methodology

Manufacturing industries take the demand of customer and service at affordable prices needs a good flow of raw materials and facilities while at the same time managing the industries' resources. Effective production planning and integration ensure that all resources essential produce goods are accessible in the right quantity, quality, and delivery time. Such production planning and integration, however, is repeatedly very intricate. For example, a usual manufacturer needed to track numerous amounts of raw materials, parts, and subassemblies for

good, well defined, and effective production. In a similar way, a service provider should be guaranteed the proper staffs and variety of required amount of materials are existing to fill the demand of numerous market segments, frequently Effective internal planning and control mechanism denotes the major “block and tackling” principal to organization’s efficient and effective operations. Planning and control are major blocks that give to the organization of wider operational systems. Forecasting customer demand based on a wide variety of business features is one serious input. Planning for processes then should be cover together with the continuing planning limit for whole capacity and process-linked resources, such as facilities, production machines, and workers, as well as comprehensive schedules, to fit the demands Albina et.al., (2017).

Three basic operations strategies can be used in the APP, along with many combinations in between, to meet the fluctuating demand over time. One basic strategy is to level the workforce; the other is to chase demand with the workforce. With a perfectly level strategy, the rate of regular time output will be constant. Any variations in demand must then be absorbed using inventories, overtime, temporary workers, subcontracting, backorders, or any of the demand-influencing options. With the chase strategy, the workforce level is changed to meet, or chase, demand. In this case, it is not necessary to carry inventory or to use any of the other variables available for APP; the workforce absorbs all the changes in demand (Jamalnia, 2019) (Reid, 2009) (Schroeder, 2003). The third strategy, the pure demand management strategy, is an approach that attempts to change or influence demand to fit available capacity by employing options such as aspiring, advertising, and developing alternative products and services (Jamalnia,2019)(slack,2013). Normally, the pure demand management policy is always considered as part of the level strategy. The present research also regards the demand management policy as a subset of level strategy. Each of the two pure plans is applied only where its advantages strongly outweigh its disadvantages. For many organizations, however, these pure approaches do not match their required combination of competitive and operational objectives. Most operations managers are required simultaneously to reduce costs and inventory, to minimize capital investment, and yet to provide a responsive and customer-oriented approach at all times. For this reason, most organizations choose to follow a mixture of the two approaches (Jamalnia, 2019) (slack, 2013).

In the current actual situation, production planning settings such as product mix, inventory status, and workforce level are so complex that the optimization technique is usually employed to tackle the complexity in determining these settings. There are two categories of effective techniques according to the current literature: they are the analytical techniques (Jordan et...al., 2002; Chinneck, 2004). The analytical techniques include linear programming (LP), goal programming, and mixed-integer programming (MIP), and they are relatively matured. Most of them have proved that optimal or near-optimal solutions can be achieved for certain types of problems (Lair, 2008). Haq et al. (1991) discussed Aggregate production planning (APP) is a tool process to balance uncertainty demand and the available resources in short-medium term planning horizons (Donatus et...al, 2017).

Cheraghalikhani (2019) argued that APP model is classified based on two criteria one is level of uncertainty existed on APP into the different structural group and the other is the number of objective function exists in the model the input data vary from deterministic, stochastic and fuzzy set. Production planning and control are simulated to visualize the production of the production process and comparison the actual data with the production plan. Shun Y (2016) state that there are key performance indicators for optimization of production planning and control are time delivery rate, quality, cost, machine utilizations, work in process, Cycle time, lead time, material utilization, But most of the research did not consider production scheduling accuracy and production planning tracking affected on production planning effectiveness From detailed review literature and the existing situation on factory it can be selected the suitable key parameters indicators and key performance indicators general purpose and the researcher select the best indicators for use for enhancing the performance production planning and control of case company and also included in the conceptual framework.

2.7.2. Key Performance Indicator

A performance indicator can be defined as “a variable that quantitatively expresses the effectiveness or efficiency, or both, of a part of or a whole process, or system, against a given norm or target” (Vladimir Jovan, 2006) (Lohman et al., 2003). Therefore, these indicators are used for enhancing production planning and controlling.

Table 1. Key performance indicator parameter

Title	Authors	KPI's
The Design of a Production Planning and Control System for a Food Manufacturing Company in a Developing Country, using Simulation	Kumbi et...al,2013	<ul style="list-style-type: none"> ✓ Inventory ✓ Rejection ratio ✓ Overall equipment effectiveness ✓ Raw materials ✓ Lead time Downtime
A Key Performance Indicator System of Process Control as a Basis for Relocation Planning,	F. Reichert	<ul style="list-style-type: none"> ✓ <i>Finance, process, Production</i> ✓ <i>Customers, employees</i>
Assessments of production performance by means of KPI's	Andrej R,2004	<ul style="list-style-type: none"> ✓ Safety and environment ✓ Efficiency ✓ Quality ✓ Production planning tracking ✓ Issue related to employee
Key Performance Indicators For Integrating Maintenance Management And Manufacturing Planning and Control	Harald Rødseth,2016	<ul style="list-style-type: none"> ✓ Dock to Dock ✓ First Time Through (FTT) ✓ Floor Space(Savings) ✓ On-Time Shipment, WIP-to-SWIP ✓ OEE, Sales per person ✓ Average cost per unit, Throughput time
Utilization of Key Performance Indicators In Production Control	Vladimir Jovan,2006	<ul style="list-style-type: none"> ✓ Productivity, (actual production rate or production yield) ✓ Product Quality (mean value of the quality factors) ✓ Production Costs
Implementing manufacturing strategy through strategic production planning	Irineu et...al,1998	<ul style="list-style-type: none"> ✓ <i>Cost</i> ✓ <i>Delivery speed</i> ✓ <i>Delivery reliability</i> ✓ <i>flexibility</i>
Production Planning and Control Strategies Used as a Gear Train for The Death and Birth of Manufacturing Industries	AlieWube et..al,2018	<ul style="list-style-type: none"> ✓ Manufacturing process Performance ✓ Problems in facility Lay-out ✓ Poor warehouse and Resource Utilization
The role of hierarchical production planning in food manufacturing SME's	Seamus et...al,2015	<ul style="list-style-type: none"> ✓ Cost ✓ Quality ✓ Delivery ✓ Flexibility

2.7.3. Conceptual Framework

In this study, production planning and control for measuring independent variables, inventory control, material requirement planning, material resource planning, lead time, capacity planning, schedule accuracy, production planning tracking would be enhancing the performance of production planning and control in Hiwot bottled water factor.

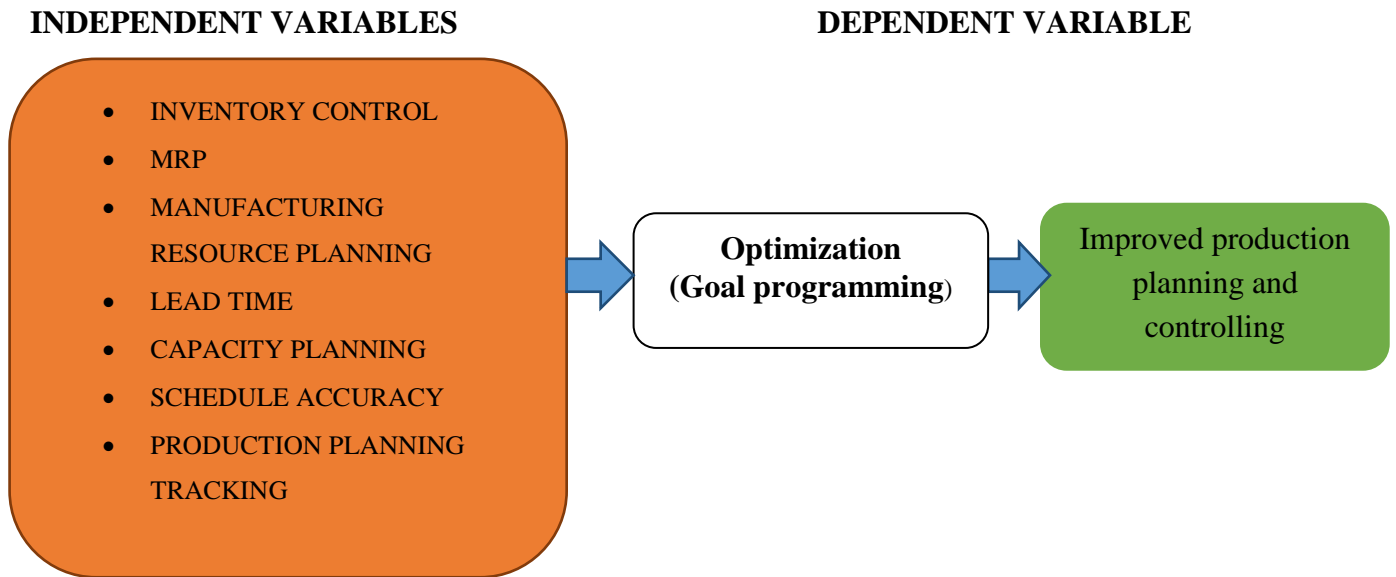


Figure 6 Conceptual Framework

2.7.4. Literature Review Summery

Table 2 Literature Review Summery

S/N	TITLE	AUTHOR	OBJECTIVE	PROBLEM	METHOD	FINDING
1	Scheduling method with time using MRP system a case study: construction project in Libya	Abdallah Ali Serbia(2015)	<ul style="list-style-type: none"> i. To investigate the impact of MRP ii. Reducing the costs iii. Improve delivery time. 	The problems of time, cost and optimal exploitation of available resources to achieve project.	✓ Descriptive analytical technique.	<ul style="list-style-type: none"> ✓ MRP system has significant. ✓ improving delivery time and services in the project.
2	Simulation module for production planning and control	Muchaet.,al Faculty of Mechanical Engineering, Macedonia(2017)	To reducing the cost and time needed to identify one that delivers the best	<ul style="list-style-type: none"> 1. Longer delivery time 2. Not efficient flow of materials 3. Poor management of organization's resources 	Software for modeling and simulation, Tecnomatix Plant Simulation	Optimizing the system of production planning and control
3	Analysis of production planning activities in remanufacturing system	M. Andrew-Muno Faculty of Engineering, University Malaysia Sarawak (2018)	To determine the best resource policy for processing	Used-products with uncertain quantities and quality conditions are sourced either from	Model development Simulation experiments by consider different variables	Reduce material and delivery time
4	Scheduling parameters in Production Planning and Control	Janreschke(2017)	To evaluate effect of a scheduling parameter variation on the target system of the PPC	Differentiation of the scheduling parameters planning horizon		Better results delivery time ,good utilization of raw material, reduce work load

5	Optimal scheduling in a milk production line	Javanmardet.,al (2011)	Optimal production scheduling in a single milk production line	Material balances, inventory limitations, machinery capacity, labor shifts and manpower restrictions	A mixed integer linear programming (milp)	Complete scheduling tool for the dairy industry.
6	Optimal Production Planning For ICI PAKISTAN Using	Khan (2011)	Earn significant profit by operating proposed production forecasts	Cost resource constraints	Revised simplex method Sensitivity analysis	Maximize the profit generated
7	Application of Linear Programming for Optimal Use of Materials in Bakery	Akpan .&Iwok, (2016)	Profit maximization	To allocate raw materials to competing variables	TORA software	decide number of production, determine maximum profit
8	Optimizing the production scheduling of fruit juice beverages	Marina (2017)		Lack of efficient, effective economical production	Optimization experiments of the simulation system	orders. time delivery rate, quality, cost, machine utilization, WIP
9	Planning model & simulation constrained by resources and materials	Wang, C.2010	Objectives of delivery on-time, reducing inventory, reducing overtime work, keeping safety inventory	Integrate and optimize the production planning, material requirements planning, resource requirements planning, inventory planning, and overtime working planning within the unified framework	LP mathematical model (lingo 11.0)	To make production plans and it has certain feasibility and effectiveness.
10	Demand forecasting for production planning in A food company	N. De P. Barbosa, E.das.Christo, and K. A	To analyze and forecast the sales demand analysis	One of the biggest challenges of food and beverage manufacturers is adjusting the production and the stocks to minimize the loss of products	Demand forecasting importance in demand and in sales	Holt-Winters method, which was applied in the time series analyzed in this work, to its short perish ability and

						consequently
11	Optimization Model for Production Planning and Scheduling	Chen, Y. X.	To establish an integrated optimization model of production planning and scheduling with consideration of logistics constraints.	The existing production plan and production scheduling are usually conducted separately.	Mathematical Model quantum particle swarm optimization (QPSO)	minimize device adjustment cost and overtime cost for distribution of each machine
12	Production Planning of LCDs: Optimal Linear Programming and Sensitivity Analysis	Al-kuhaliKet. Al (2012)	This research takes into the production of Flat Panel Monitor of four sizes and will point more the products that contribute the main function of profit.	production planning acquire of line space assembly of products Quality control	the linear programming and Sensitivity analysis	maximum profit
13	A Newextended MILP MRP Approach to Production Planning	ErhanYazJ, et.,al (2016)	To manage these reverse material flows as a part of production planning to utilize resources	a production planning problem which involves reusing of scrap and recycling	mixed integer linear programming (MILP) model	The model proposes solution to this main bottleneck application of the proposed model

CHAPTER THREE

3. Research Design and Methodology

3.1. Introduction

As it is specifying in the title, this chapter consists of the research methodology of the dissertation. In more details, in this part researcher draw round the research strategy, the research method (techniques), the research approach, the methods of data collection, and gathering of different information, sample selection, the research process, the type of data analysis, and software used, the ethical consideration, and the research limitations of the dissertation.

3.2. Research Design

Many definitions of research design have been proposed by different researchers and scholars, working in many other fields. According to (Prabhat and Meenu, 2015) A research design is simply the framework or plan for a study that is used as a direct in collecting and analyzing the data. It is a blueprint that is followed in completing a study. The research design is the blueprint for collection measurement and analysis of data. It is a map that is usually developed to guide the research.

This research will be conducted in a correlation method of research called to survey study to assess the enhancing effectiveness of production planning and control strategies using optimization tools (linear programming). The correlation research methods help to identify the key performance indicators and constraints (dependent & independent variable) and used to draw valid conclusions and recommendations.

3.3. Data Collection and Source

The source of data for this thesis from two major sources. This is primary and secondary data the source of data would be the machine operator in each production process. historical sales data or current data from test markets, the daily, monthly, yearly production report Supply and department personnel and documentation Maintenance department and mechanics, electrical, Quality control report sheet, focused on the literature reviewed at an international journal, Document, magazine, journal.

3.3.1. Data collection tools

a) Primary data

The data is come from the Hiwot bottled water factory of different department, it is more accurate, precise, and high confidential to make trusted analysis having a direct impact on the production planning and controlling efficiency.

i. Direct Observation

In this research direct observation is used as a means to evaluate the techniques used in documentation of the sales and marketing department, each production process, production material used on every process and production machine as well as the existing facilities of the industries. Important documents of the respective industries such as annual reports, technical and sales report, company profile brochure, and inspection data have been also used to perform analysis.

Contact with the marketing managerial, production and techniques department has been done to gain information like marketing demands, specification of different raw material in each process, production capacity each machine to determine machine utilization capacity, average shop floor worker to decide the number of how much the number of employees is needed.

ii. Survey Questionnaire

The questionnaire is prepared in order to obtain main information concerning the production planning that can affect suitable production planning performance and ways of forecasting technique in practice's practices of the Bottled water manufacturing industry. The questionnaire is developed aiming for responders of the educational level of Diploma and above. In general, the objectives of conducting the questionnaires are to determine the effectiveness of production planning and controlling constraints and used to assess the demand technique current in the production planning activities. These structured questions are given complete information about current production planning and controlling.

b) Secondary data

Studies done previously are used to collect different information about bottled water production processes that have been used as one of the secondary data sources. Some information is used to strengthening these studies from different web site, books, and case company. Data sources like journals, articles, literature review. different books found in the different source regarding on demand forecasting, inventory controlling technique, Bottled water production, production planning and controlling, has-been gathered to get a better understanding and information about this study and other sources such as which is directly related to the case company like daily, monthly and annual production reports report, user manual, Maintenance report, sales report, production, and raw material inventory reports, as well as a different document that are related to production planning and control of the case company. Focusing area of data collection and the review was on different production and controlling enhancing strategies, an optimization technique that helps to increase the efficiency of production planning.

3.4. Population and Sampling**a) Population**

The population of the study includes all the products produced on the factory and resources that are used for this production as well as customer demands.

b) Sampling Techniques

In drawing sampling, probabilistic sampling techniques will be used. Due to the very smaller population. All concerned the samples of the population are taken. Because the sample is selected by the following criteria respondents directly involved in production planning and controlling activity. Equation is applied to compute the initial sample size. Since the population is finite (less than 50,000), So that total number of sample are eleven and three types of company product are selected purposive sampling techniques are used to select company product (600ml,1000ml,2000ml).

3.5. Data Analysis and Interpretation tools

3.5.1. Data Analysis Tool and Methods

In these case study two main production phase are analyzed; production of bottle and bottled water production. So that, Different analyses are done on this study to optimization production planning and controlling

a. Statistical Package for the Social Sciences (SPSS)

Statistical Package for the Social Sciences are also used in analyzing the questioners obtained data .Statistical tools like correlation between the parameter are also analyzing. a SPSS software packages will be employed to analyses and interoperate the decision on the study.

i. Correlation analysis

According to Gogtay, 2017 correlation analysis, used evaluates relationship between two (or more) quantitative variables. This analysis is fundamentally based on the assumption of a straight line [linear] relationship between the quantitative variables. The end result of a correlation analysis is a Correlation coefficient whose values range from -1 to +1.

ii. Regression Analysis

According to Jihye Jeon, 2015 Regression analysis is a statistical method to study relationships between more than one independent variable randomly one dependent variable. Both regressions allow for the assessment of whether independent variables such as age, gender, education, attitude, behavior are associated with dependent variables (outcome/criterion) while controlling for the outcomes overlapping associations with other variables

b. Optimization Analysis (POM-QM software)

Goal Programming

The assumptions of the model developed in this study were based on:

- i. The number of products produced in Hiwot Bottled water factory.
- ii. Raw material requirements required to produce these products.
- iii. Inventory holding of Hiwot Bottled water factory.
- iv. The demand pattern for each product produced in Hiwot Bottled water factory, which may vary from one organization to the other which may vary from one organization to the other.

These varying aforementioned parameters in different Hiwot Bottled Water factory result into the development of unique production planning systems used in these organizations. In light of this, the assumptions of this model are highlighted as follows:

- a) Three products X_{1i} , X_{2i} , X_{3i} demanded by the customers at period i where $i = 1, 2, 3, 4, \dots, n$ are produced in a Hiwot bottled water factory.
- b) Raw materials used to produce products X_1, X_2, X_3 at period I are available in a Hiwot bottled water factory.
- c) The inventory holding capacity of products X_1, X_2, X_3 at period $i=1$ is the same as the inventory held at the last period of production based on the inventory holding policy of the Hiwot bottled water factory.
- d) The demand of X_1, X_2, X_3 in a Hiwot bottled water factory.

Notations

X_1, X_2, X_3 the quantity of products X_1, X_2, X_3 produced in each period i in a Hiwot bottled water factory.

1. $IX_i, IX_{2i},$ and IX_{3i} The amount of inventory of products X_i, X_{2i}, X_{3i} held in each period i in a Hiwot bottled water factory. $PT_{x_i}, PT_{x_{2i}}, PT_{x_{3i}}$ The time required to produce products X_1, X_2, X_3 in each period i in a Hiwot bottled water factory.
2. $PC_{X_i}, PC_{X_{2i}}, PC_{X_{3i}}$ The operating cost required to produce products x, x_{2i} and x_{3i} in each period i in a Hiwot bottled water factory DX_i, DX_{2i} and DX_{3i}

customer order for products X_1, X_2, X_3 in each period i in a Hiwot bottled water factory.

3. PTA=production time available for each period i in a Hiwot bottled water factory. PC_i = production cost for each period i in a Hiwot bottled water factory. A, B and C = inventory to be held for products X_1, X_2, X_3 in each period i in a Hiwot bottled water factory. WC_i =Warehouse capacity for each period in a Hiwot bottled water factory.

3.6. Data validity and reliability

According to (Kothari, 2004) validity is most critical is the most critical and critical criterion and indicates the degree to which an instrumentation measure what it is supposed to measure. Additionally, (Mugenda, 1999) reveals that the validity of the research tool has two components .the first is construct validity which deals with the consistency of the question with the response intended by the researcher. This validity is assured by structured by structuring the questioner according to specific objectives. The second form of validity is to connect validity, i.e. the ability of an instrument to gather the data required for the analytical technique suggested(Peli,1996).

Reliability Analysis

The test of reliability is significant for testing of sound measurement. a measuring instrument is reliable if it delivers consistent outputs. A reliable measuring instrument does contribute to validity but a reliable instrument need not be a valid instrument (Kothari, 2004). According to George et., al, 2015 Cronbach's Alpha, analyzes with correlations between all couple of items, internal consistency could deviate between zero and one, even though there are sometimes unusual negative values, as the same time (this mean a negative average covariance among items, which could mean that whereas the true population covariance's between items are positive, sampling error has produced a negative average covariance in a given sample of cases or that the items do not truly have positive covariance's, and therefore may not form a single scale, they are not measuring the same thing).

Table 3 Reliability test analysis

Variables	Cronbach's Alpha	N of Items	Internal consistence
Material Requirement Planning Application (MRP)	0.812	5	Good
Manufacturing Resource Planning and Control (MERP)	0.734	7	Acceptable
Effects of Lead Time on PPC Performance (LT)	0.782	6	Acceptable
Improving scheduling accuracy by reducing data inconsistencies (AS)	0.799	8	Acceptable
Production planning and control (PPC)	0.773	7	Acceptable
Capacity Planning (Capacity constrain)	0.735	6	Acceptable
Production Plan tracking (PT)	0.842	3	Good

3.7. Ethical Considerations

As of academic institution, the proposed research thesis was reviewed by Addis Ababa university institute of technology to ensure those study procedures are appropriate. In dealing with the respondents and company officials, which requires investigators to obtain informed consent from all subjects, protect subjects from harm and discomfort, treat all research data confidentially and explain the analysis and the results to the subjects afterward. Thus, the above ethical guidelines used in order to address the ethical considerations aspect of this thesis in an effective manner. In addition, the voluntary participation of respondents in this thesis was the main input of the thesis. Moreover, high care was taken to not use offensive, discriminatory, or other unacceptable languages in the formulation of the questionnaire. Privacy and anonymity of respondents are of paramount importance to this thesis. It mostly acknowledged works of other authors used in any part of the dissertation with the use of the referencing system. Similarly, it also determines that appropriate sample sizes and procedures are used in the analysis and that respondents were given proper care.

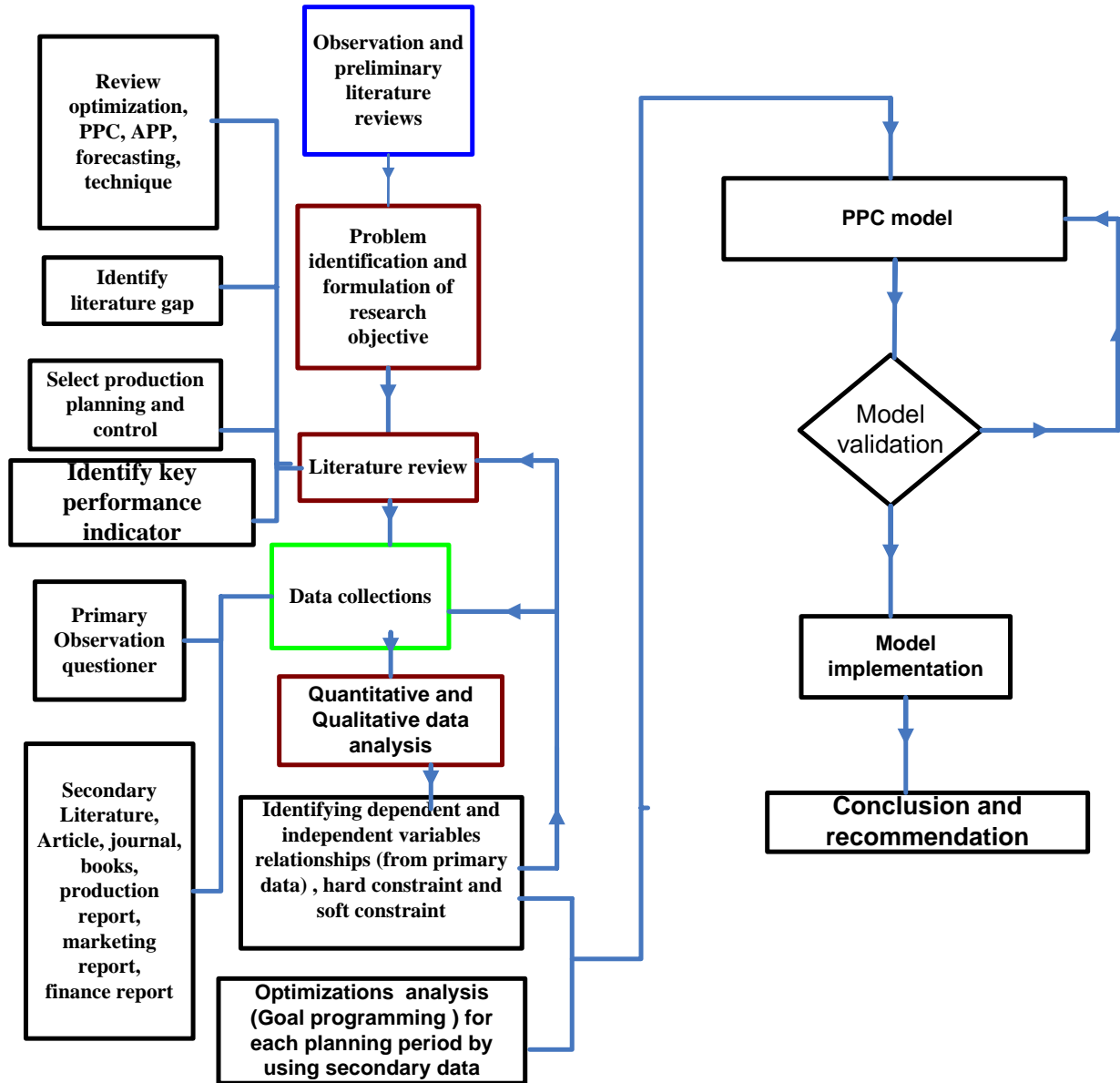


Figure 7 Research methodology frameworks

CHAPTER FOUR

4. Data Presentation, Analysis and Interpretation

4.1. Introduction

Bahiru Abraham Industry is a Leading Manufacturer Company in Ethiopia Since 1995. There are eight Different Factory, Hiwot Bottled Water Manufacturing, Bitwoded Plastic Cap & PET Preform Manufacturing, Bisrat PLC/ Different Types of Plastic Manufacturing, Modern Pipe Manufacturing, Elefign Bahiru Corrugate Steel Manufacturing 6: Selam Foam Factory, Natran Plastic Tanker Factory, Busa PLC.

This industry is standard PET (Polyethylene Terephthalate) Performs (bottles), Caps from HDPE (high-density polyethylene) and HIWOT purified natural bottled water (HPNW) manufacturing Factory. The company is located in the Oromia region, Alemgena town along with Addis Ababa to Jimma road exactly 26kms from Addis Ababa, with a plot size of 40,000 square meters. BAI is most known in Perform and Cap manufacturing, but a year ago started the water purification process and becomes a fast-growing purified bottled water factory.

HPNW uses standard PET performs which is produced in BAI perform and cap manufacturing, the sister company of HPNW to pack the product using the combined and latest technology of Blowing, Filling, and capping in one system. The capacity of the machine is 12,000 pcs per hr. for 0.6 lit, 10,000 pcs per hr. for 1.0 lit and 7,000 pcs per hr. for 2 lit. BBAI has been certified in the production of Perform and Cap with ISO 14000 Food and safety management. BAI process all products based on the national and international standard including national regulation and legislation in Ethiopia.

BAI started the development of the site by ensuring that the ecosystem was environmentally friendly and also cultivating an impressive green area to bring back the badly affected fauna and flora that once use to live there. BAI, Perform and Cap manufacturing is one of the most known and the leading company which delivers such products to different bottled water factories. The superior quality, quantity, safety, and reliability of products create confidence to the customer. The company provides a wide range of product size to the consumer.

4.2. Perform, cap and bottled water production

Perform Production process

The polymer is transported in big bags. The material once entered into the factory, is piped into storage silos from which it takes depending on the production requirements. Plasticization of the PET once dried PET is routed through a screw in the injection chamber. During the phase, the PET is heated to a temperature of about 285 and stands to the lamination phase passing from the solid-state (granules) to the liquid state. Before entering into the cochlea the granule can pass through a pre-mixer where it's mixed with Master Bache, with the specific amount, gives the shade as required by the customer.

Water purification

Hiwot purified natural water is processed and purified Groundwater, no ingredient is added at the final product and is produced using the latest purifying technology. Water treatment includes Disinfect by calcium hypochlorite, Activated carbon treatment, membrane filtration, and Ozone Sterilization. The product is mainly produced for the local market but, it can be exported with special consideration, and the intended use is for the general population including sensitive consumers' infants, elders, and others consume the product. The process aims to guarantee the highest safety standards for drinking water and ensure a taste that is in accordance with consumer preference. The final products are stored at ambient temperature, and to be protected from direct sunlight and excessive heat for the avoidance of the products physic-chemical and microbiological hazards and transported by closed vehicles. At ambient temperature, the product in bottles has a 12-month shelf life from the date of production.

Table 4 Final product typical chemical analysis and product physical analysis requirement

Typical analysis	Ca	Mg	Na	K	Cl	Na ₃ -	Alkalinity	Caco ₃	PH	TDS
mg/l	23	3	4	2	21	4	60-80	8-12	7	47-50

- a) **Cooling:** -the solidification process ends when the performs are ejected from the mold by the cooled automated gripper.
- b) **Packing:** -Once completed the cycle of cooling, the performs are deposited on conveyer belts and sent in suitable containers.

c) **Storage:** the containers are taken by automated system and stored in the warehouse ready to be transported and used.



Figure 8 Production Process of Plastic Bottle

Cap Production; is a polyethylene thermoplastic (HDPE) made from petroleum with a high strength-to-density ratio, and it's the raw material used for production of Caps. The production process is quite similar with perform production, the only difference is there is no drying process in Cap production hence HDPE has no moisture property.

4.2.1. Survey Questionnaire Analysis

In order to assess the current production planning and controlling practices of Hiwot bottled water and their performance indicators, the survey questionnaire is prepared and distributed to this company are responded to the questionnaire.

The survey questionnaire has two major parts. The first part is about respondent information which involves position, qualification, and work experience in the current company. The second part focuses on the third and the two-part focus on the assessment of existing production planning and controls practices, and factors of that affecting respectively. Information of Respondent Objective of the questionnaire is to survey the response of the workers about the following important issues. To identify Major tasks of PPC in the company, Production environment strategies, major production constraints, production forecasting, capacity utilization. Respondent the analysis is done for each part of the survey questionnaire as follows.

The positions of the respondents are machine operators, shift leaders, production supervisor, production head and production and technique head, production controller the respondent are qualified in the B.SC mechanical engineering and B.Sc. Food engineering. Diploma in mechanical engineering technology and a diploma in electrical engineering. Its work experience in the company is from two to five years. The respondent information is summarized as shown below.

Table 5 Position of the respondents by number and percentage (Source: Survey questionnaire)

Current position in the factory	Frequency	Education back ground	Service level	Questioner part
Production planner	3	Degree	2	Part one
Production and technique head	1	Degree	5	
Production shift leader	3	Degree	3	
Production supervisor	3	Degree	2 and half	
Production controller	1	Degree	2	

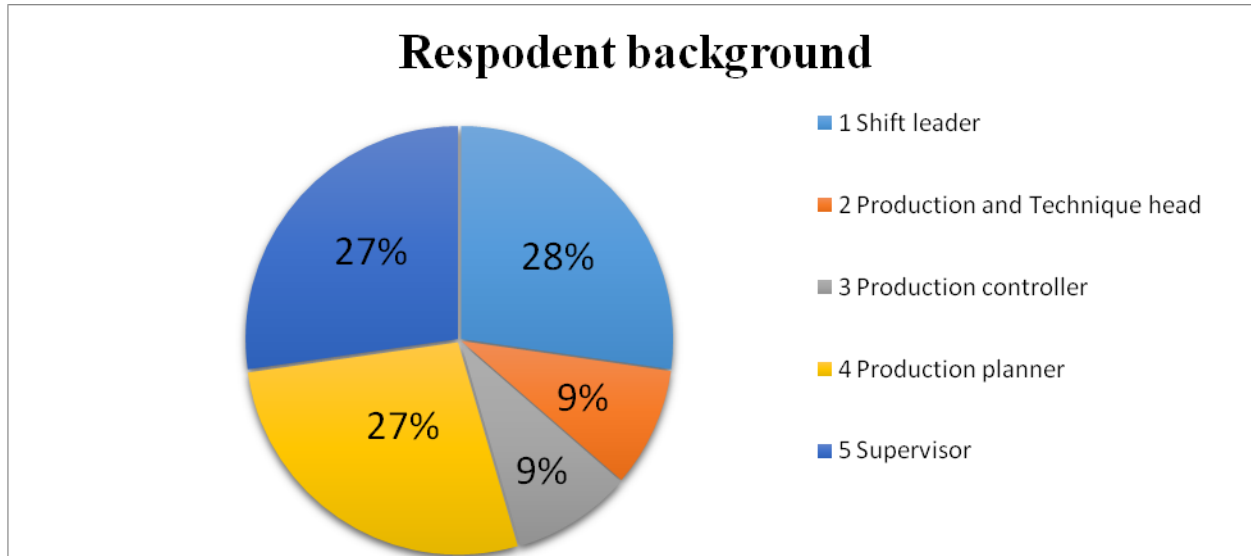


Figure 9 Qualification of the respondents by number and percentage

4.2.2. Description Analysis (part I)

Inventory control

The relevance of inventory control to production planning and controlling is major aspect in the manufacturing industries. So that the table shows the response of the relevance of inventory control to production planning and control in bottled water factory.

Table 6 Inventory Control

VARIABLE	MEAN	S.D
Order is reaches a predetermined level	2.00	0.694
Continuous inventory system and System flexibility	2.272	0.367
Inventory is automatically updated after a transaction is made	2.22	1.009
Orders are placed at specific time	2.63	0.67
Larger safety stock is required in periodic review	2.454	0.834
Replacement quantities change from one order to another	2.55	1.095
Inventory reviews are used effective inventory management	3.090	0.243
Items are ordered based on a request or at the time of the demand	2.00	0.632
Mean	2.368	0.693

Source: *survey output*

From table 6 a mean response of 2.36 showed that inventory control in the existing situation below-average level which means needs improvement and also inventory system and system flexibility strongly affected the performance of production planning and controlling. In the same mean response, 2.363 signified that orders are placed at specific time intervals are needed some improvement to enhance the performance of PPC. In the same mean response of 2.00 showed that some item is ordered at the time of the demand is below average level this performance level affects the performance of PPC and the customer demand satisfaction. The mean response 2.454 indicated that large safety stock is not available on inventory this will leads the factory PPC to need extra working for larger safety stock. According to mean value (2.55) the quality changes from one order to others are neutral responses because most production processes are pass through in high production planning quality measure.

Further. The mean values 3.02 are inventory review are necessary for effective inventory control is average level on the bases of respondents. The overall mean response of 2.3 of the entire question with a standard deviation of 0.63 showed that inventory control significantly affects the performance of production planning.

Effect of material requirement planning on PPC

In arriving at an important decision on the degree of utilization of production planning and control by Hiwot bottled water, information on the material requirement and level of its execution must be known had given importance to the expediency and different features of materials for manufacture.

Table 7 Effects Material Requirement Planning on PPC

VARIABLES	MEAN	STD.DEVIATION
On time delivery of production material	3.1818	0.873
Quality of raw material	4.09	0.700
Planning for production material, production equipment and manpower is efficient	2.545	0.687
Raw material requirement matches with production capacity	3.000	0.774
Product quality reduces customers complaints due to raw material selection	3.636	0.924
Mean	3.2905	0.7916

Source: *Own survey*

Table 7 shows the level of application and implementation of the material required planning by the examiner organizations based on the questionnaire. The mean response of 3.181 showed that production materials are well-timed make available before the production process starts. the quality of the product produced decrease satisfaction from customers which come up due to raw material selection, as this was indicated by a mean response of 3.866. Besides planning on human-equipment relations improve production, as the mean response of 2.545 recommended. Similarly, the mean response of 2.545 explained that the raw material needed for the production of any specific product matched with the production capacity, and finally, due to production planning, thus, the overall mean response of the entire questions on current material requirement planning by the Hiwot Bottled Water is 3.2905, while the standard deviation was 0.7916. This shows that there was average production planning and control of material requirement so that it needs improvement in the factory.

Effects Production (manufacturing) Resource Planning and Control

To resolve whether production resource planning was implemented by Hiwot water factory, questions concerning to planning and control on manufacturing resource were asked as shown in

Table 8 Effects Production (manufacturing)Resource Planning and Control

VARIABLE	MEAN	STD.DEVIATION
Availability of a master production schedule in company	3.09	1.136
Factory Production Schedule is Efficient	2.909	0.943
Equipment / personnel are allocated as per requirement	3.272	1.009
Allocation of Materials/Equipment/Personnel to Production Units is Efficient	2.272	0.904
Materials Required for Production are Determined by Production Schedule	2.363	0.809
Working environment of your employees is efficient	2.636	0.674
The production capacity is allocated based on individual orders	2.272	1.009
Mean	2.687	0.926

Source: *survey output*

Table 8 Show the level production (manufacturing) resources planning were applied by the Hiwot Bottled Water factories manufacturing industries. Thus, for production scheduling, the mean response of 3.090 showed that it was not much satisfactory level, the mean response of 2.99 explained that materials required for production are determined by production schedule, the mean answer of 3.272 signified that allocation of materials/equipment/personnel to production units were averagely efficient not sufficient compared to the company needs. The material required to be determined by the production schedule (mean=2. 363) was below averaged due to this production planning (scheduling) is needed. Also, and lastly, the mean responses of 2.636 showed that the working environments of your employees are efficient workers were very week. In general mean response of 2.687 of the entire questions on current level manufacturing resources planning by the factory with a standard deviation of 0.041 indicates week production (manufacturing) resources planning was applied by companies on manufacturing resources.

The level of lead time on PPC performance

The importance of lead time to production planning and controlling is major aspect in the manufacturing industries. So that, the table shows the response of the relevance of lead time to production planning and control in bottled water factory.

Table 9 Effects of Lead Time on PPC Performance

VARIABLE	N VALID	MEAN	STD. DEVIATION
Minimization in inventories	11	3.454	0.522
Shorter production cycle times	11	3.090	0.943
Reduced obsolescence and excess	11	3.818	0.873
Improvement in product quality	11	3.363	0.809
Increased profitability	11	2.636	0.809
Increased customer satisfaction	11	2.818	0.404
	Mean	3.363	0.726

Source: *survey output*

The above tables 9 Show Effects of Lead Time on PPC Performance were applied by the Hiwot Bottled Water factories manufacturing industries. The data shows the mean of the six variables is between 2.8 and 3.60 and the standard deviation of these variables is between 0.404 and 0.943. The overall mean value of Effects of Lead Time on PPC Performance of the respondents' response is in the category of moderately agree. The mean response of 3.090 showed that Shorter production cycle times are at an average level. The mean value of response to question Reduced obsolescence and excess are strong (mean=3. 818) this shows the excess and outdated are produced. On the base of quality improvement in the company had an average (3. 363) in the general mean response of 3.36. Of the entire questions on Effects of Lead Time on PPC Performance by the factory with a standard deviation of 0.7 indicates moderately Lead Time was applied by this factory.

Improving scheduling accuracy

The relevance of Improving scheduling accuracy to production planning and controlling is also aspect in the manufacturing industries. So that, the table shows the response of the relevance of lead time to production planning and control in bottled water factory.

Table 10 improving scheduling accuracy by reducing data inconsistencies

VARIABLE	N	MEAN	STD. DEVIATION	
In a production forecasting demand	11	2.4545	0.68755	
Inaccurate set-up time and processing time	11	3.1818	0.87386	
No feedback regarding engaged work stations	11	2.8182	0.60302	
Inconsistent a digital record of the time of occurrence of a particular task	11	2.7273	1.00905	
Absence of any appropriate production information	11	2.9091	0.53936	
Mismatch of planned work stations	11	3.3636	0.50452	
	Mean	11	2.99	0.7028

Source: *survey output*

According to the table 10, almost all the entire respondent (mean=2.99) preferred the category of average in all six variables on critical used for increasing the accuracy of the scheduling by considering different aspects listed on the tables. The mean of the four variables is between 2.454 and 3.363 and the standard deviations of these variables are between 0.539 and 1.009. The overall mean value of demand fulfillment of the respondents' response is moderate or in the category of agree (2.454), this means very low in the data consistency. The mean response 3.1818 means it is average value- based on rank is given so that some further arrangement and for improving set-up and processing time. According to the respondent Inconsistent a digital record of the time of occurrence of a particular task are in the average value (mean= 2.7273) and feedback related to work. The station is medium based as shown in mean value 2.8182 this implies that proper information flow is not sufficient there on the work station and availability of appropriate information are in moderate level (2.909) this would lead to decrease the accuracy level of production scheduling.

Production Planning and Control

Regarding Production Planning and Control, this thesis tried to know the participant's opinion on Minimizing in case of stock-outs, Easy controlling of processes from all department, Easy managing of products from raw materials to finished products, means of improving production performance, Reduction of overload processes, Easier management processes.

Table 11 Respondents' response on production planning and control

VARIABLE	MEAN	STD.DEVIATION
Minimizing in case of stock outs	2.64	0.674
Easy controlling of processes from all department	2.91	0.943
Improved information communication between different sections	2.55	0.687
Easy managing of products from production started to finished products	2.36	0.674
Means of monitoring operator performance	3.00	0.894
Reduction of machine idleness	3.00	0.774
Easier management processes	3.00	0.447
Mean	2.78	0.727

Source: *survey output*

The table 10 shows that minimizing in case of stock out (mean 2.64) and easy for the managing of products from production started finished products (mean=2.36) were realized that less than the moderate-level. This shows that PPC of the company based on the respondent information needs improvement. The mean responds 2.55 experience of information communication within the factory had below the average level this means it needs some development to improve the

performance of PPC. However, both the variables (mean=3.00) moderately experience on the current situation in the production planning on process management and reduction on machine idleness and managing each process. In general mean response of 2.787 of the entire questions on current level PPC by the factory with a standard deviation of 0.727 indicates week production planning was applied by the company.

Impact Capacity planning (capacity planning) on PPC

About capacity planning, the following items were included in the thesis are shows number of a product are accumulated in store, proper allocation of goods in the area, man the power needed for specific types of demand, level of overtime in production, rescheduling frequency and how to use production facilities on the base of the demand plan and rescheduling.

Table 12 Respondents' response on Capacity planning

VARIABLE	NVALID	MEAN	STD.DEVIATION
Excess numbers of products in store	11	2.727	0.646
All goods have properly allocated placement areas	11	3.090	0.301
Staff working hours are scheduled according to demand	11	2.545	0.687
High level of overtime worked by staff	11	3.181	0.603
Rescheduling frequency at production facilities due to change in demand plans	11	3.090	0.539
Production facilities operate according to demand plan scheduling	11	3.181	0.603
Mean		2.969	0.563

Source: *survey output*

The above tables Impact Capacity planning (capacity constraint) on PPC by the Hiwot Bottled Water factories manufacturing industries. The data show the mean of the six variables is between 2.5 and 3.1 and the standard deviation of these variables is between 0.301 and 0.687. The overall mean value of 'Impact Capacity planning (capacity constraint) on PPC' response is in the category of the less average value. The mean response of 2.727 showed that Excess numbers of products in a temporary holding area are lower because of poor planning activity. the mean value of response on question All goods have properly allocated placement areas (mean=3.090) this shows this average level agree the respondent would lead the company for wastage of different resources. The mean 2.545 indicated the working hour of the company when there is demand the scheduling efficacy are lowed as the respondent are agreed with average so that this working hour arrangement the factory lead to unsatisfied the customer demand and also the level of overtime are on an average level(mean=3.181) that shows the factory reduces in overtime payment in moderate level but still needed improvement due to poor planning .finally production

facilities are rescheduling in similar ways in average level (mean=3.09) and also operate this facility in accordance with demand are needed improvement because as mean value indicated. in the general mean response of 2.969. Of the whole questions on Impact Capacity planning (capacity constraint by the factory with a standard deviation of 0.5 indicates below the average level was applied by this factory.

The effect of production planning tracking on PPC performance

About production planning tracking, the following items were included on the thesis are shows Percent of production orders finished late, Number of penalties, Percent of production orders finished ahead.

Table 13 Respondents' response on Production plan tracking

VARIABLES	N VALID	MEAN	STD.DEVIATION
Percent of production orders finished late	11	3.00	0.774
Number of penalties	11	2.81	0.603
Percent of production orders finished ahead	11	3.00	0.774
Mean		2.93	0.717

Source: *survey output*

According to the table 13, almost all the entire respondent (mean=2.93) preferred the category of average in all three variables on critical used to increase the Production plan tracking by considering different measurements listed on the tables. The mean of the four variables is between 2.81 and 3.00 and the standard deviation of these variables is between 0.603 and 0.774. The overall mean value of demand fulfillment of the respondents' response is moderate or in the category of agree (2.936) this means tracking needs some improving. According to the respondent Percent of production, orders finished late are in the average value (mean= 3.00) Percent of production orders finished ahead 3.00 this implies that lack of proper production planning tracking would lead the factor lead time are increased lateness in the production activity and a number of planate is in the average level (mean=2.81)also would lead the company on less profit.

4.2.3. Correlation analysis

Table 14 Person Correlation analysis

Factors	Production Planning and Control	Inventory	Material Required Planning	Material Resource Planning	Lead Time	Schedule Accuracy	Capacity Constraint	Production Tracking
Production Planning And Control	1	-	-	-	-	-	-	-
Inventory control	.53*	1	-	-	-	-	-	-
	11	11	-	-	-	-	-	-
Material Required Planning	.693*	.656*	1	-	-	-	-	-
	11	11	11	-	-	-	-	-
Enterprise Resource Planning	.667*	.615*	.856**	1	-	-	-	-
	11	11	11	11	-	-	-	-
Lead Time	.731**	0.275	.736**	0.54	1	-	-	-
	11	11	11	11	11	-	-	-
Schedule Accuracy	.747**	.616*	.759**	.741**	.083	1	-	-
	11	11	11	11	11	11	-	-
Capacity planning	.787**	.563*	.513*	.359*	0.329	0.477	1	-
	11	11	11	11	11	11	11	-
Production Planning Tracking	0.630*	0.342	.577*	0.031	.854**	0.319	.668*	1

As shown in table 14 The study established there was a positive and significant relationship between production planning and controlling (0.53, 0.693, 0.667, 0.731, 0.747, 0.787,0.630), inventory control, material requirement planning, enterprise resource, lead time, scheduling accuracy, capacity planning, and production tracking. The ratings showed that inventory control played a vital role in the production planning, and control performance, and as such, factory must make sure that inventory control is highly involved in the production control things, hence, achieving higher production planning, and controlling performance. Results also showed that the coefficient correlation between inventory control systems and production planning is 0.53. This meant there was a positive relationship between inventory control, and production planning of Hiwot bottled water factory.

It was also obvious from the findings of the study that lead time gives to production planning effectiveness. Lead time showed how the factory obtains competitive advantages as it delivers the right product at the correct place, and within the shortest time possible. Further, the results illustrated that the correlation coefficient between lead time, and production planning and control is 0.0.731. Hence, it can be deduced there was a strong positive relationship between production

planning, and lead time. The results also showed that the coefficient correlation between Enterprise Resource Planning and production planning is 0.67.

4.2.4. Regression analysis

Regression analysis is used to “model “this relationship so as to able to predict outcome variables and what will happen in real-world is setting (Njgogtay, 2017). The analysis has to identify the impact of the variable on production planning.

Table 15 Model Summary

Table 4. 1Model Summary Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.814 ^a	.662	.683	.5932
a. Predictors: (Constant), PRODUCTION TRACKING, MATERIALRESOURCE PLANNING, CAPACITY CONSTRAINT, INVENTORY, SCHEDULE ACCURACY, LEAD TIME, MATERIAL REQUARED PLANNING				

Source: *survey output*

The finding on the tables 15 shows that R square was 0.814 at 0.05 level of significance. the coefficient of determination indicator 66.2% of the variation in efficiency on production planning and control on Hiwot Bottled Water Factory would be explained in inventory control, material requirement planning, enterprise resource planning, lead time, production planning tracking, scheduling accuracy, and capacity constraint. The remaining 33.8 %are explained by the table.

Table 16 above presents the beta coefficient of are all independent variables versus the dependent variable.

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.234	19.541		0.614	0.511
INVENTORY CONTROL	0.538	0.42	0.201	0.329	0.000
MATERIAL REQUARED PLANNING	0.63	0.335	0.638	0.032	0.000
MANUFACTURING RESOURCE PLANNING	0.605	0.588	0.588	5.001	0.000
LEAD TIME	0.904	0.437	0.281	0.325	0.018
SCHEDULE ACCURACY	0.731	0.038	0.627	0.704	0.000
CAPACITY CONSTRAINT	0.53	0.066	0.356	0.549	0.002
PRODUCTION TRACKING	0.272	0.139	0.709	2.595	0.000
a. Dependent Variable: PRODUCTION PLANNING and CONTROL					

Source: *survey output*

The regression model written as;

$(Y=B_0+B_1X_1+B_2X_2+B_3X_3+B_4X_4+e)$ now becomes

$$Y=0.234+0.538X_1+0.630X_2+0.605X_3+0.904X_4+.731X_5+.530X_6+.272X_7$$

the coefficient beta shows positive relationships with production planning and controls. Unit increase the controls increase with the effectiveness of production planning and controlling by 0. 538. Units increasing in material requirement planning would lead to an increase in the effectiveness of production planning and control. A unit increase in the resource planning which is used to enhance the effectiveness of production planning and controls by 0. 605. Unit value increase in the shortest lead time will affect production planning and controlling efficiency.0.731 increment in scheduling accuracy would lead to an increase in the performance of planning and controls. 0.530 amount of unit increase capacity constraint consideration with the increase in production planning and controls. 0.272 increment of production tracking planning would increase the accuracy of production planning. all variables test were statistically significant value($p<0.05$), P-value $X_1=0\%, X_2=0\%, X_3=1.8, X_4=0.018, X_5=0.000, X_6=0.000, X_7=0.000$

Model Summary

Anova analysis

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	75.993	7	10.856	19.841	.000 ^b
Residual	38.734	3	12.911		
Total	114.727	10			
a. Dependent Variable: PRODUCTION PLANNING and CONTROL					
b. Predictors: (Constant), PRODUCTION TRACKING, ENTERPRISE RESOURCE PLANNING, CAPACITY CONSTRAINT, INVENTORY, SCHEDULE ACCURACY, LEAD TIME, MATERIAL REQUIRED PLANNING					

Source: *survey output*

Using Z statistics, alpha=5%, numerators $df=4$, and denominators $df=7$ F critical=19.841The results on the table above show that the P-value significance of F statistics is0.000, which is less than 0.05 and value of F(19.841) being significant at 5% confidence level. This implies that data was significant for making a conclusion that is the predictors variable. Their regression analysis indicates that the significant P-value of F-statistics is less than 0.05 at 0.00.this implies that the independent variables (inventory control, production tracking material requirement planning, enter preserve source planning, lead time, schedule accuracy, capacity constrain..) actual explain the production planning which means that the model is significant.

4.2.5. Goal Programming Data Analysis

Objectives of the Model

The seven key objectives of the Hiwot bottled water factory considered by the authors are highlighted as follows:

1. Priority objective 1: meet the demand of product X_1 in each period i . The flexibility constraint associated with this objective is given as $IX_{i-1} + X_i - IX_i = DX_i$.
2. Priority objective 2: meet the demand of product Y in each period i . The flexibility constraint associated with this objective is given as $IX_{2(i-1)} + X_{2i} - IX_{2i} = DX_{2i}$.
3. Priority objective 3: meet the demand of product Y in each period i . The flexibility constraint associated with this objective is given as $IX_{3(i-1)} + X_{3i} - IX_{3i} = DX_{3i}$.
4. Priority objective 4: minimize the production cost incurred in producing products X_1, X_2, X_3 in each period $PC_{1i} + PC_{2i} + PC_{3i} = PC_{ix}$
5. Priority objective 5: hold an inventory of A, B and C for the product X_1, X_2, X_3 at the last of period of production. the flexibility constraint associated with this objective is given as $IX_n = A, IX_n = B, IX_n = C$
6. The warehouse constraint associated with this objective is given as

$$IX_{i-1} + IX_{i-1} + IX_{i1} = WC_i$$

7. Priority objective 7: minimize the production time used in producing products X_1, X_2, X_3 in each period i the flexibility constraint associated with this objective is given as $PT_{i-x}^{xi} + PT_{i-x2}^{xi} + PT_{i-x3}^{xi} = PTA$

Rigid constraints of the Hiwot bottled water factory

The various constraints that the system of the Hiwot bottled water factory faces in meeting the aforementioned objectives are:

- i. Production system capacity constraint in meeting the demand of products, which in this case, is determined using PTA in each period.
- ii. The inventory holding capacity constraint of products based on the inventory policy of the Hiwot bottled water.
- iii. The warehouse capacity constraint to hold products in each period i there for WC_i .

4.2.6. Goal programming Model Formulation

Minimize $\{d_{i-DX1}^-, d_{i-DX2}^-, d_{i-DX3}^-, d_{i-PC}^+, d_{i-A}^-, d_{i-A}^+, d_{i-B}^-, d_{i-B}^+, d_{i-C}^-, d_{i-C}^+, d_{i-WC}^+, d_{i-PTA}^+\}$

Subject to X_1, X_2, X_3

$$IX_{i-1} + X_i - IX_i = DX_i.$$

$$IX_{2(i-1)} + X_{2i} - IX_{2i} = DX_{2i}.$$

$$IX_{3(i-1)} + X_{3i} - IX_{3i} = DX_{3i}$$

$$PC_{iX} + PC_{iX2} + PC_{iX3} + d_{i-PTA}^- + d_{i-PTA}^+ = PC_{iX}$$

$$IX_n + d_{i-A}^- + d_{i-A}^+ = A$$

$$IX_n + d_{i-B}^- + d_{i-B}^+ = B$$

$$IX_n + d_{i-C}^- + d_{i-C}^+ = C$$

$$IX_{i-1} + IX_{i-1} + IX_{i-1} + d_{i-WC}^+ + d_{i-WC}^+ = WC_i$$

$$PT_{i-x}^{xi} + PT_{i-x2}^{xi} + PT_{i-x3}^{xi} = PTA$$

All decision variables ≥ 0

Production Operations Data of the Hiwot Bottled Water

The production planning data used to solve the goal programming model of this factory was obtained through production running time and the production methods that are currently applied on the production floor.

The data collected in this factory include the customer order for three major bottled water products for four quarters of a year, maximum inventory holding of this factory at the beginning and ending a period of production, the time required to produce 600ml, 1000ml and 2000ml bottled water products, the production time available to produce these bottled water products, the production time available per week to produce these bottled water products, the operating cost required to produce 600ml, 1000ml and 2000ml bottled water products, and the production cost available per week to produce these bottled water products demanded by the customers.

Demand and Process Operations Data of the Hiwot Bottled Water

The goal programming model of the Hiwot bottled water factory was parameterized and solved using POM-QM software package.

The production cost of their product varied due to some additional items cost varies through time and the value are averagely taken from cost financing department

Table 17 Production Cost

Time	600ml	1000ml	2000ml
January	2.61	4	5.21
February	2.67	4.09	5.41
March	2.57	3.92	5.23
April	2.68	4.12	5.37
May	2.34	3.58	4.67
June	2.55	3.91	5.09
July	2.72	4.18	5.45
August	2.91	4.3	5.83
September	2.97	4.41	6.24
October	3.06	4.5	6.67
November	3.18	4.53	7.14
December	3.66	4.54	8.61

Source; *cost financing report*

The ware house capacity the factory varies throughout the year because the company use some other store by rent

Table 18 warehouse capacity

Time	X_1	X_2	X_3
January	1048860	1117590	515424
February	1130892	206184	447444
March	442632	1138932	552042
April	529980	236412	536730
May	1120596	1025214	501000
June	1539092	513378	424110
July	1353720	235134	512244
August	1704792	859956	110766
September	1255752	837984	208782
October	1658160	512670	503946
November	1101288	881238	649182
December	1093080	1053774	487722

Source: *survey output*

Inventory holding capacity within the production department and factory are by don't considering defective product

Table 19 Inventory holding

S/N	Time	Types of product		
		600ml	1000ml	2000ml
1	January	1,048,860	1,117,590	810,252
2	February	1,130,892	1,323,774	959,736
3	March	442,632	1,345,116	975,209
4	April	529,980	1,375,344	997,124
5	May	1,120,596	1,261,626	914,678
6	June	1,539,092	1,538,592	1,115,479
7	July	1,353,720	748,512	542,671
8	August	1,704,792	1,095,090	793,940
9	September	1,255,752	1,697,940	1,231,006
10	October	1,658,160	1,350,654	979,224
11	November	1,101,288	1,393,908	1,010,583
12	December	1,093,080	1,117,590	810,252

Source; data analysis output

4.2.7. Results and Discussion of the Model Solution

Table 20 Production plan solution output of the model is presented

PRODUCTIONPLAN (Decision Variables)	X ₁	X ₂	X ₃	Production Plan/Decision Variable	IX ₁	IX ₂	IX ₃
1st Production Plan	833,971	1,012,522	1006,173	1st Inventory Plan	442,632	345,116	975,209
2nd Production Plan	1980,141	858,612	838,613	2nd Inventory Plan	1,539,092	1,538,592	1,115,479
3rd Production Plan	1,230,293	526,615	503,431	3rd Inventory Plan	1,255,752	1,697,940	1,231,006
4th Production Plan	1,075,892	682,631	562,630	4th Inventory Plan	1,093,080	1,117,590	810,252

Source data analysis output

Based on the above table 4. 13. 7, it could be concluded that the production of Hiwot bottled water needs to produce 833,971, 1980141, 1075892 and 1012522, 858612, 526615, 682631, and 1006173, 838613, 503431, 562630 units of 600ml, 1000ml, 2000ml of bottled water respectively in order to achieve the customer demand throughout the year. The inventory holding of in the four

Quarters are 442632,1539092,1255752,1093080 in first quarter 345116, 1538592, 1697940, 1117590 and the fourth quarter 975209,1115479,1231006,810,2

Table 21 First quarters the result of based on constraints is presented.

Priority Objective	Goal	Achievable/ Non-achievable	Resource, Availability, Demand, Targets and System, Capacity Constraints	d^+	d^-
Priority Objective 1	Goal1- 4	(0, 0, 0, 0)	87471.73, 104966.1, 136455.9	(0,0,0)	(0,0,0,0,)
Priority Objective 2	Goal5-8	(0, 0, 0, 0)	136196, 104966,135342,	(0,0,0)	(0, 0,0,0)
Priority Objective 3	Goal9-12	(0, 0, 0, 0)	135342, 3419284, 3686708, 1442980	(0,0,0)	(0,0,0,0)
Priority Objective 4	Goal24-27	(0,0, 1530438, 1878087)	145, 1947507, 169064, 2085866	(0,0,0)	(0,0, 1530438, 1878087)
Priority Objective 5	Goal13-15	(0,0,0)	2369291, 437110.1	(0,0,0)	(0,0,0)
Priority Objective 6	Goal20-23	(15.32, 10.27, 144.54,144.85)	16.5, 11.4,156, 163	(0,0,0)	(15.32, 10.27, 144.54,144.85)
Priority Objective 7	Goal16-19	(2159276, 2557642, 2598875, 14.65)	2271725 ,2690836 ,2734217	(0,0,0)	(2159276, 2557642, 2598875, 14.65)

Source: *data analysis*

Based on the above table, it could be concluded that goal 1, 2, 3 and 5 can be achieved with the resources currently available in Hiwot bottled water since the deviational variable ; d_1^+ to d_{12}^+ are equal to zero so that the objective four can be attained in January, February, March, but cannot attain in this period from January to march deviational from d_{24}^+ d_{25}^+ d_{26}^+ and d_{27} are 0, 0, 1530438, 1878087 respectively, the value $d_{25}^+=1530438$, $d_{26}^+= 1878087$ showed that the production costs in these time intervals are underutilized. The percentage utilization in these two month are 19.49%, 21.13%. Objective 6 can be achieved since the value of deviation d_{20}^+ , d_{21}^+ , d_{22}^+ , d_{23}^+ should be zero but the value of d_{20}^- d_{21}^- d_{22}^- and d_{23}^- which are 15.32, 10.27, 144.54,144.85, Show that the warehouse capacity will be under capacity during the first quarter period 91.31%,80.2%,75.3%,78.4% respectively. Objective 7 from these it could be concluded that production time during each week of production to meet customer demand.

Second quarter

Table 22 Second quarters the result of based on constraints.

Priority Objective	Goal	Achievable / Non-achievable	Resource, Availability, Demand, Targets and System, Capacity Constraints	d^+	d^-
Priority Objective 1	Goal1-4	(0,0,0,0)	(87471.73, 96679.27, 82867.95, 136196)	(0,0,20270,0)	(0,0,0,0)
Priority Objective 2	Goal 6-8	(0,0,0,0)	(129027.8, 135342, 149588.5)	(0,0,0)	(0,0,0,0)
Priority Objective 3	Goal9-12	(0,0,0)	(128218.7, 1722435, 1722435, 3641937, 5002049)	(0,0,0)	(0,0,0)
Priority Objective 4	Goal24-27	(274.54, 1858514, 1543387, 1219324)	(314, 2028011, 1893007, 1602481)	(0,0,0)	(274.54,0, 1543387,0)
Priority Objective 5	Goal13-15	(481367, 2087479, 1045309)	(501193, 2173454, 1088361)	(0,0,0)	(481367, 2087479, 1045309)
Priority Objective 6	Goal20-23	(10.35, 11.75, 145.56, 308.34)	(11.5, 13, 168, 350)	(0,0,0)	(10.35, 11.75, 145.56, 308.34)
Priority Objective 7	Goal16-19	(0,0,0)	(2805702, 2573717, 12.52)	(0,0,0)	(0,0,0)

Source data analysis output

Based on the table 22, it could be concluded that goal 1, 2, 3 and 5 can be achieved with the resources currently available in Hiwot bottled water since the deviational variable but cannot be achieved since the value of the deviational variables $d_3^+ = 20270$ and d_1^+ to d_{12}^+ are equal to zero so that the objective four can be attained in April, May, June, but cannot attain in this period from January to march deviational from d_{24}^+ d_{25}^+ d_{26}^+ and d_{27} are 274.54, 0, 1543387, 0 respectively, the value $d_{24}^+ = 274.54$, $d_{26}^+ = 1543387$ showed that the production costs in these time intervals are underutilized. The percentage utilization in these two month are 19.49% ,21.13%. objective 6 can be achieved since the value of deviation d_{20}^+ , d_{21}^+ , d_{22}^+ , d_{23}^+ should be zero but the value of d_{20}^- d_{21}^- d_{22}^- and d_{23}^- which are 10.35, 11.75, 145.56, 308.34 Show that the warehouse capacity will be under capacity during the first quarter period 87.04%,81.2%,70.1%,73.4% respectively. Objective 7 from these it could be concluded that production time during each week of production to meet customer demand.

Table 23 Third quarter the result based on constraints is presented

Priority Objective	Goal	Achievable / Non-achievable	Resource availability, Demand Targets and Capacity Constraints	d^+	d^-
Priority Objective 1	Goal1-4	(0,0,0,0)	(55245, 55245, 55245, 86019)	(0,0,0)	(0,0,0,0)
Priority Objective 2	Goal 6-8	(0,0,0)	(86019,86019, 85479)	(0,0,0)	(0,0,0)
Priority Objective 3	Goal 9-12	(0,0,0,0)	(85479,4738020, 4395132,498484)	(0,0,0)	(0,0,0,0)
Priority Objective 4	Goal 24-27	(218.15, 1731244, 159643.1, 581415.9)	(242, 1935491, 418524.5, 788873.6)	(0,0,0)	(218.15, 1731244, 159643.1, 581415.9)
Priority Objective 5	Goal 13-15	(486572, 1779541, 1734073)	(498484.1, 1823107, 1776526)	(0,0,0)	(486572, 1779541, 1734073)
Priority Objective 6	Goal 20-23	(8.33, 8.33, 8.6, 543.43, 558.98)	(9.2, 9.5, 602, 615, 615)	(0,0,0)	(8.33, 8.33, 8.6, 543.43, 558.98)
Priority Objective 7	Goal 16-19	(0,0,0,0)	(1521500, 2225990, 3451403, 8.7)	(0,0,0)	(0,0,0,0)

Source: *data analysis output*

Based on the above table, it could be concluded that goal 1, 2, 3 and 5 can be achieved with the resources currently available in Hiwot bottled water since the deviational variable d_1^+ to d_{27}^+ are equal to zero so that the objective four can be attained in July, August, September, but cannot attain in this period from three month deviational from $d_{24}^+, d_{25}^+, d_{26}^+$ and d_{27}^- are 218.15, 1731244, 159643.1, 581415.9 respectively, Showed that the production costs in these time intervals are underutilized. The percentage utilization in these two month are 9.49% ,11.3% .objective 6 can be achieved since the value of deviation $d_{20}^+, d_{21}^+, d_{22}^+, d_{23}^+$ should be zero but the value of $d_{20}^-, d_{21}^-, d_{22}^-, d_{23}^-$ which are 8.33, 8.33, 8.6, 543.43, 558.98 Show that the warehouse capacity will be under capacity during the first quarter period 81.31%,95.2%,89.3%,88.4% respectively. Objective 7 from these it could be concluded that production time during each week of production to meet customer demand.

Table 24 Fourth quarter the result of based on constraints is presented

Priority Objective	Goal	Achievable/ Non-achievable	Resource, Availability, Demand, Targets and System, Capacity Constraints	d^+	d^-
Priority Objective 1	Goal 1-4	(0, 0, 0, 0)	64453, 78264, 82868, 100355	(0, 538521.4,0)	(0,0,0,0)
Priority Objective 2	Goal 6-8	(0, 0, 0, 0)	129028, 99726, 121095, 121095	(0,0,0)	(0,0,0,0,0)
Priority Objective 3	Goal 9-12	(0, 0, 0, 0)	128219, 5389020, 3579186, 3552510	(0,0,0)	(00,0, 2341827)
Priority Objective 4	Goal 24-27	(0, 0, 0, 0)	199, 1904138, 2452906, 1842836	(86.11, 1131353, 86.11,0, 1131353)	(0,0,0,0)
Priority Objective 5	Goal13-15	(0, 0, 0, 0)	1086860, 1868225, 2234001	(0,0,0)	(0,0,0)
Priority Objective 6	Goal20-23	(0, 0, 0, 0)	10.1, 11.1, 175, 185	(0,0,0)	(5.79, 6.13, 80.37, 86.11)
Priority Objective 7	Goal16-19	(0, 0, 0, 0)	199, 1904138, 2452906, 1842836	(0,0,0)	(0,0,0)

Source: *data analysis output*

Based on the table 24, it could be concluded that goal 1, 2, 3 and 5 can be achieved with the resources currently available in Hiwot bottled water since the deviational variable but cannot be achieved since the value of the deviational variables $d_2^+ = 538521.4$ and d_1^+ to d_{12}^+ are equal to zero so that the objective four can be attained in October, November, December, but cannot attain in this period from January to march deviational from d_{24}^+ d_{25}^+ d_{26}^+ and d_{27} are 86.11,1131353, 86.11,0, 1131353,0respectively, the value $d_{24}^+ = 86.11$ showed that the production costs in these time intervals are underutilized. The percentage utilization in these two month are 25.49%, 72.13%. Objective 6 can be achieved since the value of deviation $d_{20}^+, d_{21}^+, d_{22}^+, d_{23}^+$ should be zero but the value of $d_{20}^-, d_{21}^-, d_{22}^-$ and d_{23}^- which are 5.79, 6.13, 80.37, 86.11 Show that the warehouse capacity will be under capacity during the first quarter period 88.05%,80.2%,71.1%,74.4% respectively. Objective 7 from these it could be concluded that production time during each week of production to meet customer demand.

4.2.8. Summary of findings

According to the analysis done in the previous section, summary of the finding is presented as follows

- ∞ The company current production planning and controlling has stated on the table 4.3 planning activity are done mostly using different time boundary (weekly, monthly, quarterly) but the forecasting demand with very low accuracy level
- ∞ The production was affected due to resource constraint like material, manpower, store, time
From these constraints lack of storage space is highly influenced production and limits production quantity. The material requirement planning doesn't clearly defined or there are some accuracy problems on how much is needed on for production purpose but dispatching of this resource are relatively good. In Addition to this the company uses 60 to 70 % of total production capacity and there is less customer satisfaction due to longer delivery time the company.
- ∞ The major factor that affect production planning and controlling or key performance indicator are material requirement planning, manufacturing resource planning, inventory control, capacity planning, production scheduling accuracy due to data inconsistency are identified for this case company.
- ∞ The inventory controlling system below the mean average (2.368) shows in table 4.4 and the production order are not placed on time, lack of continues inventory mechanism, low system flexibility in the company this shows production planning
- ∞ The material requirement planning effects on production planning and controlling of the Hiwot bottled water factory in average (3.00) level but the material quality is high (4.00) but this quality matches to production machine capacity are in average level.
- ∞ According to table 4.6 shows that production scheduling efficacy is in average value (2.909 but the production resource allocation with in production system is lower than average (2.363) and the material required determined by production scheduled is also the same (2.363). Therefore, this shows that there should be improvement in production planning.

- ∞ Generally, the effect of lead time, production schedule accuracy is in average level but overall production planning and control is stated on table 4.9 is mean average (2.78) shows that there should be improvement in this area.
- ∞ All independent variables varies are positively and significantly correlated is positive and significant. The significances level varies from variable to variables and this is proven by regression analysis.
- ∞ As per regression analysis results indicates in MRP, LT, SA, PT, CP, IC, manufacturing resource planning have positive and significant effect on production planning and control the p-value less than 0.05.
- ∞ The Goal programming analysis shows how the product demand is affected on different season and additive decomposition forecasting method is lower MAPE so it is better for forecasting methods.
- ∞ For the first quarter deviational variable; d_{1+} to d_{12+} are equal to zero so that the objective four can be attained in January, February, March, but cannot attain in this period from January to march deviational from d_{24+} d_{25+} d_{26+} and d_{27} are 0, 0, 1530438, 1878087 respectively, the value $d_{25+}=1530438$, $d_{26+}= 1878087$.
- ∞ For the second quarter the analysis showed that the production costs in these time intervals are underutilized. The percentage utilization in these two month are 19.49% ,21.13%. Objective 6 can be achieved since the value of deviation d_{20-} , d_{21-} , d_{22-} and d_{23} should be zero but the value of d_{20-} , d_{21-} , d_{22-} and d_{23-} which are 10.35, 11.75, 145.56, 308.34.
- ∞ Between July to September the production costs reduced and the resource in these time intervals are underutilized. The percentage utilization in two consecutive months are 9.49%, 11.3%.
- ∞ The warehouse capacity will be under capacity during the first quarter to fourth quarter year. For instance, fourth period utilization of are 88.05%, 80.2%, 71.1%, 74.4%.
- ∞ Based on the result attained, it was decided that objective 1,2,3 and 5 of the factory can attained. objective 6 of the enterprise can also achieve.

CHAPTER FIVE

5. Production Planning and Control Improvement Model

5.1 Introduction

After conducting a detailed literature review, sector review, and similar bottled water production factories. The next step was data collection through a different mechanism as like direct observation, develop questioner to directly involved production planner on the base of key performance indicators in the factory, operators that are involved in filling the production data in the factory and supervisors; then all the collected data was analyzed and interpreted based on the reviewed and finding the results the researchers like Emrah..et..al,2014 Include mostly considered basic MRP, MRPII, capacity planning but this model is different from because of two main reasons; First, it is developed with the consideration of their existing situation by collecting primary data from different work level. Second, this model develops to enhancing the performance of production planning and control; with this regard, it adds additional performance indicators like production schedule data accuracy consistency and production planning tracking. But after conducting forecasting analysis and reviewing the experience of bottled water factories the researcher includes demand management and measuring errors in furcating accuracy. Additionally, the model includes the master production scheduling after validating the model their main reason is some necessary information is included in this concept which is not included in others. Therefore, the final production planning model as shown in figure 5.1 includes material resource planning, manufacturing resource planning, lead time, inventory control, production planning tracking, production scheduling accuracy, capacity planning, production planning, and controlling.

5.2 Improvement Model Description

a) Capacity planning

Capacity planning refers the entire planning activity within function of enter functional department and members the main aim of capacity is improvement the overall performance process of the enterprises from customer order to planning as result planning process are in suitable manner and enhance production planning. The capacity planning problem critical problem for factory's. Both the analysis result of correlation and regression also proves the impact of capacity planning on production planning and controlling performance and also clearly indicates on the model. To obtain an effective solution from the model, factory should focus and work on capacity planning.

b) Manufacturing resource planning

Manufacturing resource planning is very important planning types for any manufacturing firms. This planning activity consider resource which are directly or indirectly related to the company so that in order to enhance the performance of PPC, better resource planning is needed. The correlation and regression analysis indicates that it has strong relationship with PPC and manufacturing resource planning are focused on material, manpower, equipment efficiency on production quantity.

c) Material resource planning

Material requirement planning is also significant variables which highly affected the performance of PPC, this is also confirm by correlation and regression analysis, Therefore the factory should focus on material resource planning tasks; on time delivery of production raw material to specific process, quality of raw material in the production process, customer complaint due to material choice, material utilization efficiency, this helps the factory to enhance efficiency of PPC and also used long term relationship with the customer.

d) Lead time

Lead time is mandatory for any manufacturing firms, which highly affected the performance of PPC, correlation and regression analysis indicates longer lead time will affect the production planning cycle time, quality, profitability of the company (cost), inventories on shop floor and

also high impact on customer satisfaction so that, the factory should work on this to get better result and also managers' supports this activity together to achieve the goal.

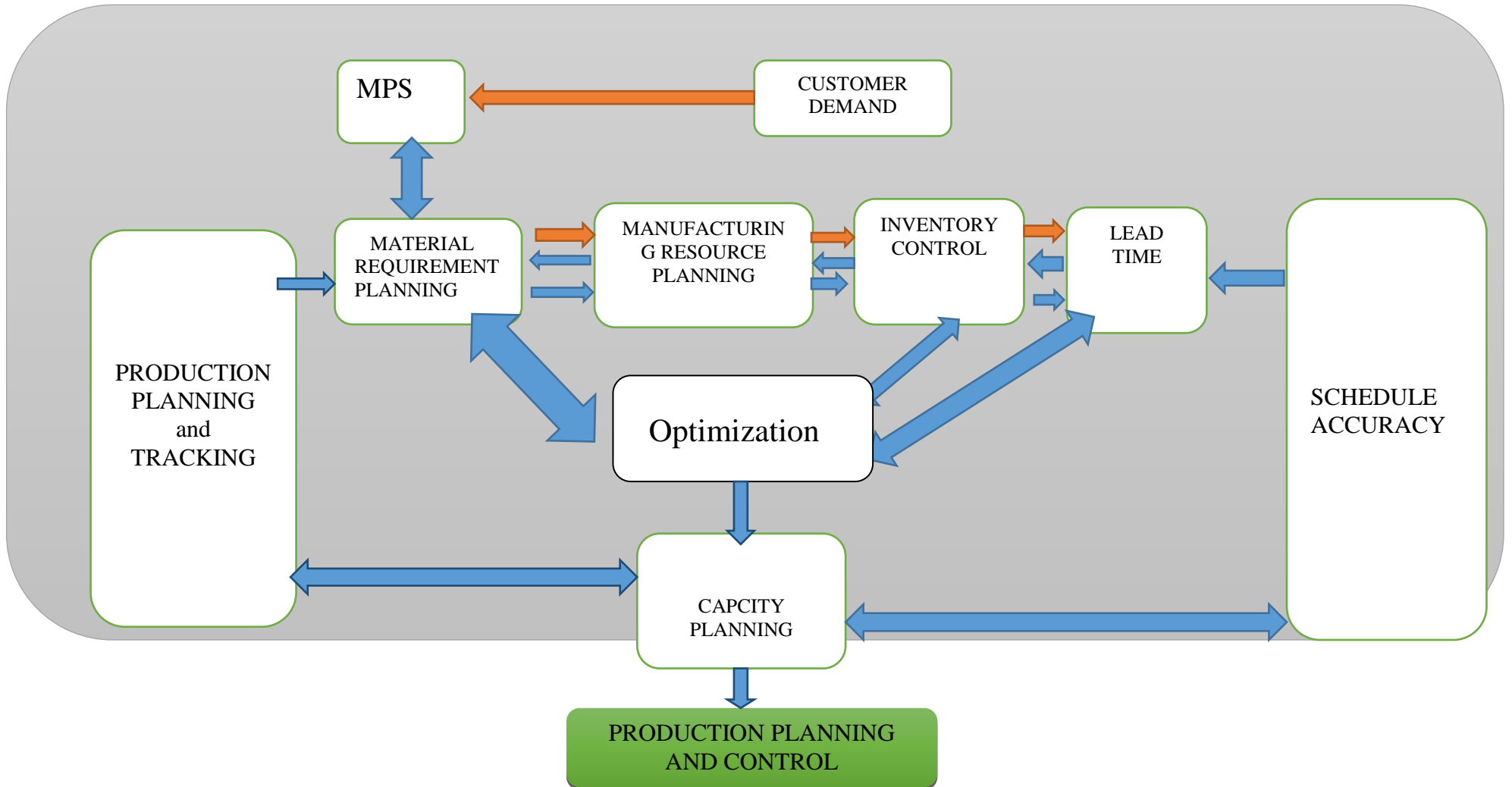
e) Production planning tracking

Production planning tracking is planning efficiency should measure based on the criteria stated on production planning and also considers percentage order filled and percentage of production orders filled ahead. Therefore, all planning activity are measure based on time and value.

f) Production scheduling accuracy by data inconsistency

Production scheduling accuracy by data inconsistency is other significant component which can affect the production planning performance. correlation and regression analysis indicates the significance level of this accuracy data consistency value. Therefore, the factory should focus and work on production scheduling accuracy like data inconsistency of production forecasting, processing time, missing any relevant information on production systems and mismatch between planned work stations. The company is most beneficiary by correcting these consistency level.

Customer demand is another significant component for production planning and controls so that the expertise opinions also confirmed that without properly consider the demand company may lead to production loss. This demand is evaluated throughout the seasons because it is very fluctuated demand.



5.3. Model Validation

According to (Kothari, 2004) hypothesis testing determines the validity of the assumption with the view to choose between two conflicting hypotheses about the value of the population parameter. But other argue about the biasness of the first assumption .therefore to solve the problem test model with a reasonable representation of the actual system the expert's opinions and comment were collected, after doing regression analysis and develop first draft model; the interview was conducted three expertise; Hiwot bottled water general manager, Hiwot bottled water production manager and technique, Aden bottled water production manager with considering spastically teste results (included MRP, material requirement planning, lead time. Scheduling data accuracy, inventory control, capacity planning, and planning tracking).

They all suggest including master production scheduling by considering demand forecasting and their reasons for was working material requirement planning primarily needs to generate data relevant from master production scheduling and customer demand. Therefore, by combining valuable comment with the study major finding, the researcher develops a model which enhances the performance of PPC.

5.4. Model Implementation Procedure

After the development of the model, there should be a way that shows the models are implemented So that the researcher suggested some implementation procedure in the figures.

1. In the production planning and controlling there are different key performance indicators in planning activity within Hiwot bottled Water Company.
2. Create awareness and preparing different kinds of format sheets by considering performance variables and come up with understanding the whole production planning and controlling.
3. Collect feedback from awareness creation and different format sheets if necessary.
4. Selecting the department, provide training about PPC, shearing experience.
5. Implement the model within the Hiwot production department.
6. Manage the implemented PPC.
7. Measure the performance in termers of indicators.
8. Evaluate the performance, if not accurate redesign the model and it is successful then implement it for other enterprises.

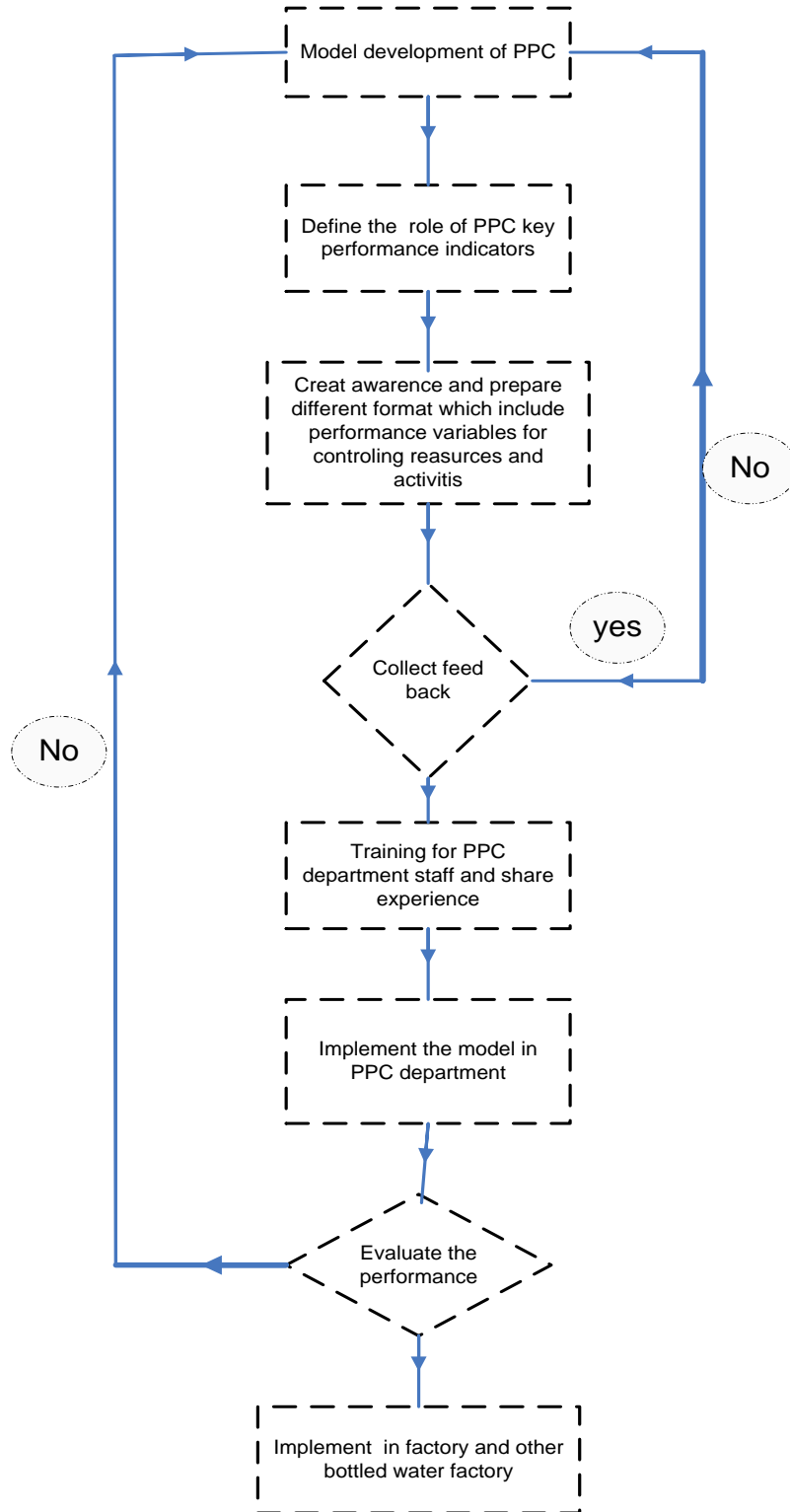


Figure 10 Model implementation procedure

CHAPTER SIX

6. Conclusion and Recommendation

6.1. Conclusion

The results in this research study identify the key performance indicators of production planning and control that used to enhance the performance of production planning and controlling of Hiwot bottled water factory. The production planning and controlling depend on inventory control, lead time, material requirement planning, manufacturing resource planning, production scheduling accuracy by reducing data inconsistency, production planning tracking, and also significantly affected the performance. The regression analysis shows that there is significant evidence on the relationship between production planning and the above variable. Similarly, the correlation analysis and expert's suggestion supports the significance of all variables (dependent and independent) in addition to this the forecasting analysis shows clearly that the seasonality of the major product.

The goal programming model that may be used to plan the production of 600ml,1000ml,2000ml product of product demand by different time periods and customer in a Hiwot Bottled Water Factory. The current production system was used to solve the model. Based on the result attained, it was decided that objective 1,2,3 and 5 of the factory can attained. objective 6 of factory can achieve. However, Objective seven and fourth cannot attained the objective of the company were due to the deviation of the result. Therefore, it could be concluded that goal programming model can be used to optimally plan, reduce cost, effective utilization of resource and used to enhance planning performance of Hiwot bottled water in order to Satisfy the customer demand.

The supplementary, result shows that performance of production planning and controlling for Hiwot Bottled water factory needs the efforts of the different departments which are directly related to the production department and production to get better inventory control, on-time delivery of material and product. The researcher also recommended to factory manager and production planning staff to strengthen the production planning and control.

6.2. Recommendation

From the research findings, the suggests the following points as credible recommendation to problems.

- ◆ Periodical review of production planning and control should be serious considered in order to detect any possible error in production system.
- ◆ Proper production planning should be performed by all component are required for effective production in the factory.
- ◆ Implementation the proposed model is better for factory increasing the efficiency of production planning by reducing production lead time.
- ◆ Without the good production planning and control to the factory it is impossible to sustain in the market shear and increase the profit of the factory. In order to achieve Better communication between department and using different software for managing the PPC within the factory.
- ◆ As any bottled factory quality of product are needed in order to maintain such standard it better train the production staff for better result and also use for increase the manpower efficiency.
- ◆ Data are collected and analyze system should improve in better way by using digital system and any kinds of error are managed with the help of this system.
- ◆ Production planning and control scheduling accuracy should increase by using better information communication system, well organized customer data and skilled manpower.

6.3. Future Study Area

This study focus on Hiwot bottled water factory but that it is advantageous to implement to see the impact in other factories. Identifying production planning and controlling indicators which are not looking in this study, implementing the new integrated model on other operational and production area of the factory-like integration of furcating demand and linear programming to get better results. The research made till now has to be tested either implemented properly or not. If the researches have done should be implemented by testing the feasibility of all the research made by so many scholars until today and set rules on how to implement the study, then check the validity in practical.

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Addis Ababa University
Addis Ababa Institute of technology
School of Mechanical and industrial Engineering
Industrial Engineering Stream
Enhancing effectiveness of production planning and controlling
strategies Concepts
Questioner

Dear Participants;

I am TassewNigussie conducting a thesis with title- “Enhancing effectiveness of production planning and controlling strategies Concept” for partial fulfillment of M.SC in industrial engineering at AAIT, AAU. With sincerity I would like to extend my deep appreciation to your company and respondents for the willingness and cooperation in undertaking this research. I request your kind cooperation in answering the questions as truthfully as possible. For other questions pertaining to this study, please contact Addis Ababa University, Addis Ababa Institute of Technology, School of Industrial and Mechanical Engineering. The information obtained from this questionnaire will be kept confidential and will not be used for any other purposes.

NB:

- ✓ For the closed ended questions in use(✓) mark for your choice in the given box and fill space provided

THE PURPOSE THIS QUESTIONER

The purpose of this questioner is to collect data on the enhancing production planning and controlling strategies of Hiwot Bottled Water Factory. So, you are kindly requested to answer correctly and honestly. These questioner questions are prepared specifically to the employees which are directly involved on production panning and controlling task on the factory.

General information

Shift leader supervisor production head production and technique head

Production Planning and Control

Instruction: Read carefully and tick (√) the appropriate option that indicates your opinion on the application and implementation of production planning and control in your company

Strongly Agree (SA) = 5, Agree (A) = 4, Average (Av) = 3, Neutral (N) = 2 and Disagree (D) = 1

Table; Inventory Control

S/N	STATEMENT	5	4	3	2	1
1	An order is placed only when inventory reaches a predetermined level					
2	There is continuous inventory system and System flexibility					
3	Inventory is automatically updated after a transaction is made					
4	Orders are placed at specific time intervals					
5	Higher inventory level or larger safety stock is required in periodic review system					
6	Replacement quantities change from one order to another					
7	Inventory reviews are necessary for effective inventory management					
8	Some items are only ordered based on a request or at the time of the demand					

Table; Material Requirement Planning

S/N	STATEMENT	5	4	3	2	1
1	on time delivery of production material					
2	Quality of raw material					
3	planning for production material, production equipment and manpower is efficient					
4	Raw material requirement matches with production capacity					
5	Product quality reduces customers complaints due to raw material selection					

Table; Implementation of Manufacturing Resource Planning and Control

S/N	STATEMENT	5	4	3	2	1
1	There is a master production schedule in company					
2	Factory Production Schedule is Efficient					
3	Equipment and personnel are allocated as per the requirement per requisition of department					
4	Allocation of Materials/Equipment/Personnel to Production Units is Efficient					
5	Materials Required for Production are Determined by Production Schedule					
6	Working environment of your employees is efficient					
7	The production capacity is allocated based on individual orders					

Table; Effects of Lead Time on PPC Performance

S/N	STATEMENT	5	4	3	2	1
1	minimization in inventories					
2	Shorter production cycle times					
3	Reduced obsolescence and excess					
4	Improvement in product quality					
5	Increased profitability					
6	Increased customer satisfaction					

Table; Improving scheduling accuracy by reducing data inconsistencies

S/N	STATEMENT	5	4	3	2	1
1	In a production forecasting demand					
2	inaccurate set-up time and processing time					
3	No feedback regarding engaged work stations					
4	Inconsistent a digital record of the time of occurrence of a particular task					
5	Absence of any appropriate production information					
6	Mismatch of planned work stations					

Table; Implementation of production planning and control

S/N	STATEMENT	5	4	3	2	1
1	Minimizing in case of stock outs					
2	Easy controlling of processes from all department					
3	Improved information communication between different sections					
4	Easy managing of products from production started to finished products					
5	Means of monitoring operator performance					
6	Reduction of machine idleness					
7	Easier management processes					
8	Minimizing in case of stock outs					

Table; Capacity constraints

S/N	STATEMENT	5	4	3	2	1
1	Excess numbers of products in store					
2	All goods have properly allocated placement areas					
3	Staff working hours are scheduled according to demand					
4	High level of overtime worked by staff					
5	Rescheduling frequency at production facilities due to change in demand plans					
6	Production facilities operate according to demand plan scheduling					

Table; Production plan tracking

S/N	STATEMENT	5	4	3	2	1
1	Percent of production orders finished late					
2	Number of penalties					
3	Percent of production orders finished ahead					

INTERVIEW QUESTION FOR MODEL VALIDATION

1. Dose strong relationship between performance indicator (LT, MRP, Material resource planning, CRP, SA, CP, PT) on production planning performance? YES NO
2. If your answer “NO” what is your recommendation rather than the above listed variables?
3. Does strong PPC satisfies the customer demand as compared to company performance? YES NO
4. If your answer “NO” what kind of variable should include on the model?
5. Does the PPC helps to enhance the performance of the company productivity? YES NO
6. If your answer “NO” what kind of variable should include on the model?
7. Does the PPC are helps to demand integration with other performance indicators?
8. If your answer “NO” what kind of your suggestion?