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Research Article

Optimization of Inventory Controlling System Using Integrated Seasonal Forecasting and Integer Programming

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Abstract

Ethiopia's industrial development strategy is characterized by manufacturing-led and expansion labor-intensive industrialization. The country expects to generate more income from the exported market. However, the case company is still known not to become productive as much as possible due to different reasons. One of the big challenges of the company has the problem with holding inappropriate inventory and with determines their optimal cost due to poor production planning. So that to solve this problem objective of the paper is to minimize total cost through the integration of seasonal forecasting and integer programming model without violating demand fulfillments. This technique improves resource utilization and enhances inventory control or stock control system. Currently, the company produces different kinds of products grouped into four common types of products (knitted garment, knitted fabric, woven garment, and woven fabric). The data survey system was both primary and secondary system and classified the products using A B C (always better classification) classification. The optimal solution was settled through the integration of seasonal forecasting and integer programming. As the Sensitivity analysis indicated the a big gap between production capacity and actual demand of the products. As the optimized solution indicated that total cost of production cost and inventory cost was minimized and the optimal production plan as well safety stock levels in each quarter was settled. Seasonal demand forecasting is a key activity for a garment which more or less controls all activities of production processes since garment products are affected by seasonal. As the result and discussion have shown that after optimized increase profit of the company through minimizing production cost and inventory costs since both costs are the big constraint of the company. Based on the optimized solution finding annually total cost needs for each A, B, and C – categories products are 57,225,920 BIRR 4,733,013 BIRR, 8,229,309 BIRR, respectively for production and inventory costs. The optimized solution indicated that if the company implemented exactly the proposed solution it will get an additional,4,219,788.8 BIRR,772,055.8 BIRR,2,119,824.2 BIRR respectively for A, B, C categories products totally around 7,111,668.8 BIRR profit per year will get. To end, it was concluded that this remarkable profit increment of the case company can certainly enhance its productivity and worldwide competitiveness. This research will create further pathways for other researchers to accomplish substantial studies on other garment sectors or other manufacturing industries based on local and international perspectives.

Keywords :ABC classification; seasonal forecasting; optimization; integer programming

1. Introduction and Background

According to (Roushdy, 2016), report inventory optimization remains one of the key challenges in garment sectors. Decisions related to amounts and timings of inventories are critical to have a responsive and efficient stock level. Integrate of Seasonal demand forecasting and integer programming is the most important one for garment sectors to cover the risk of variation in demand and supply rate. According to researchers (Luca, G., Luca, P., Maria Elena, N., 2013) and (Dmitry, I., Jorn chonberger., 2017), reporting their finding that demand forecasting in garment finished product is one of the crucial issues for driving efficient operations management plans as well as enables to provide a high level of service, which is so significant for companies to survive in worldwide market competitions and to minimize total costs. According to (Woubante, G. W,2017) and (Ph.D., 2018), demand forecasting plays important role in basic operation management as input for production planning and to set the level of inventory based on the forecasting demand indirectly used to minimize total inventory costs. According to (Anthony S. White & Michael, C., 2016) and (Dr.md.Mamun,.H., 2018), report indicated that to minimize production and inventory cost an optimization model is the most significant to determine a safety stock level that guarantees the performance measure under the worst case of lead-time demand, of which the distribution is unknown in an incomplete way. Most researchers have shown that optimization tools are used to increase total profit by minimizing total costs. Integrated seasonal forecasting and integer - programming is the key solutions for the mention problems since seasonal demand forecasting is input for optimization. According to (Sergii, K., 2015) and (Raymond, H., Jon, L., Matthias, K., 2014), the Integer-programming model arises in practically every area of application of mathematical programming, special

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in production planning and inventory controlling system has significant impacts. Integer- programming method is one of the digital decision-making techniques, is also used in the determination of production capacity and leveling inventory holding capacity.

According to the researchers (Tesfaye,G., Tesfu, B., Berihu, Z., Senait, A., 2016),] optimization of using linear programming mainly is used in manufacturing companies, maximizing revenue and minimizing the cost of production and inventory costs as well as integer programming is more advanced than linear programming so it's really important for minimizing production and inventory costs. An unreliable way to solve using linear programming is a problem when decision variables are integers.

According to research findings of (Sergii, K., Yousef, I., Mujahed, A., 2015), Many companies and government agencies have saved millions of dollars in the successful application of by implementing integer programming. According to the researchers (Zeger, D., Martina, V., 1995) When a firm is faced with the problem of inventory management or inventory cost of like garment finished products then it's better to modeling using linear integer programming techniques have been applied to minimize the total inventory and production costs. Some researchers have been studied and recommended ways to use mathematical models to solve procurement problems and to increase the profit of the companies. According to (A.C.ucorh, 2013) and (Martin, 1999), integer programming is a method of allocating resources optimally. It is one of the most widely used operations research tools to determine optimal resource utilization. According to (Broek) integer programming is a mathematical technique and an aspect of operations research whose primary function is to maximize profit and to control inventory through optimization production planning of the firm means to minimize total costs. According to (lyer, 2017) and (Naliu, Shuyun,R., Tsan-Ming, C., Chi-Leung, H.,& Sau-Fun,N., 2013), forecasting is defined as the prediction of an actual value in a future period and used to set production planning and to know safety stock levels. According to this researcher (Zhang, 2015),state on his research finding that forecasting supplies information of what may occur in the future and is used to estimate when an event is probably to happen so that proper action can be taken.

According to (Stipak) report that Integer programming models are very similar to linear programming models; they differ only to the extent that integer programming models require some or all of the decision variables to have integer means whole numbers. Although the integer requirement is a seemingly modest change from linear programming, it significantly expands our ability to model and solve constraints of manufacturing processes. According to (A.c.uzorh, 2013) report indicated that integer linear programming has significant impacts on cost minimization and increase the total profit of manufacturing companies as the research finding shown the result from the model that the total profit in the case company by 4% using if implement the company which developed by integer programming in the production planning. according to (Woubante, G. W., 2017), findings of the study show that the profit of the company can be improved by 59.84%, that is, the total profit of Birr 465,456 per month can be increased to Birr 777,877.3 per month by applying linear programming models if customer orders have to be satisfied also linear programming is a similar function with integer programming but integer programming is more advanced than linear programming because linear programming is not optimized integer numbers. Based on the above information's integration of seasonal forecasting and linear integer programming is key tools for minimizing production costs and inventory costs.

2. Problem Statement

The case study company has produced different types of products which supply to export and local markets. However, the company faced so many problems some of the challenges are holding inappropriate inventory and none determine their optimal cost due to poor production planning. The inappropriate inventory holds expose the company to unnecessary costs. As mention above due to production planning problems and lack of a scientific method of demand forecasting the company became non-productive as much as possible. Since garment products are affected by season the company needs to forecast demand, classified the products into ABC categories, and optimized production planning as well as optimal safety stock levels to minimize the total cost of the company.

2.1 General objective of the study

Due to the above mention problem general objective of this project is optimization of inventory controlling system through integrated of seasonal forecasting and linear integrated programming to minimize the inventory waste?

2.2.1 Specific objective

To assess current performance of the company in terms of inventory handling system

To calculate seasonal forecasting for demand of the finished product using POM-QM

To optimize inventory controlling system using combination of forecasting and integrated programming

Data collection → ABC analysis → Demand forecasting to each ABC → Optimized

Fig. 1.Methodology flow of the research

3. Methodology

The literature and other information have related to this work had been collected from different articles, books to understand the application of integer programming, seasonal forecasting strategy, and research of the sectors also surveyed from their manual and historical data of the companies of Ethiopia. Seasonal forecasting is one of the key models for garment finished product control or inventory control system since garment products are affected by seasonal factors. Integer- programming is the best tool for optimizing inventory controlling systems. POM-QM software was conduct in this research work for both seasonal forecasting and integer programming. The approach of this research was included both qualitative and quantitative, but the last analysis was quantitative. In this research, both primary and secondary data were included. The secondary data were collected from literature and the manual of the company and the primary data from direct observation and recording during manufacturing processes. Both seasonal forecasting and integer programming were conducted with POM-QM software in this research to study error analysis and optimize optimal solutions. The error analysis tools in this study based on historical data were Mean Absolute, Deviation (MAD), Mean Square Error (MSE), and seasonal factors had used to compute the degree of forecast errors.

This study classified the products into ABC (always better controls) categories using POM-QM software and for each classified seasonal forecasted and optimized. According to (Ram B. Misra, 2014), ABC analysis is a well-established categorization technique based on the Pareto Principle for determining which items should get priority attention in inventory management. ABC analysis is a technique for prioritizing the management of inventory. Demand forecasts are necessary to the most basics processes in any organization. The demand forecast is one of the critical issues to plan all business decisions: safety stock level, production management, and logistics.

4. Result and Discussion

Optimization of the inventory control system was conducted with a combination of seasonal forecasting and integer programming. Scientific Inventory management systems and production planning are the most critical organizational resources in the garment industry. The aim of this research is to determine the optimum solution means at lowest inventory costs to run the factory since in Ethiopia at this time so many apparel industries are available this research will serve as a benchmark for their inventory control systems. Currently, the company manufactures knitted garments, knitted fabric, woven garments, and woven fabric. To execute the mathematical programming model POM-QM optimization software was used, which is a robust computer package with a high capacity for processing problems with a number of variables and constraints..

Table 1
data taken from the company

S/N	Products Type	Unit Price in birr	Production Capacity per day	Types
1	Military Uniform	550	1390	Woven
2	Bed Cover	270	1500	Woven
3	Classical Trouser	250	400	Woven
4	Jeans Trouser	250	400	Woven
5	Work Wear	222	400	Woven
6	Bed Sheets	210	2000	Woven
7	Classical Shirt	200	377	Knitted Shirt
8	Jeans Shirt	175	380	Woven
9	Polo T-Shirt	57	600	Knitted Fabric
10	Basic T-Shirt	45	10000	Knitted Fabric
11	Caps	34	600	Woven

4.1 ABC –analysis

This projects ABC classification done based on the annual birr consumption. This annual consumption value is calculated with the formula: (Annual demand) x (item cost per unit) and used Prioritization of the management attention; the ABC analysis (or Selective Inventory Control) is an inventory categorization technique. ABC analysis divides an inventory into three categories in terms of control "A items" with very tight control and accurate records, "B items" with less tightly controlled and good records, and "C items" with the simplest controls possible and minimal records. If the company classified the products and materials with this rule the company will improve its material productivity and material management.

Table 2
ABC –analysis

Item name	Demand	Price	Dollar Volume	Percent of $-Vol	Cumulative $-vol %	Category
Item 1	1390	550	764500	30.28	30.28	A
Item 10	10000	45	450000	17.82	48.1	A
Item 6	2000	210	420000	16.63	64.74	A
Item 2	1500	270	405000	16.04	80.78	A
Item 3	400	250	100000	3.96	84.74	B
Item 4	400	250	100000	3.96	88.7	B
Item 5	400	222	88800	3.52	92.22	B
Item 7	377	200	75400	2.99	95.2	C
Item 8	380	175	66500	2.63	97.84	C
Item 9	600	57	34200	1.35	99.19	C
Item 11	600	34	20400	0.81	100	C
TOTAL	18047		2524800			

4.2 Seasonal forecasting

Based on historical data Mean Absolute Deviation (MAD), Mean Square Error (MSE), and seasonal should calculate using POM-QM software to compute the degree of forecast errors. In this study indicated of each products holding cost was 10% include (Holding cost=cost/unit/year *(cost of money + taxes + insurance + warehouse expense +physical handling + clerical and inventory control + obsolescence + deterioration and pilferage).

Table 3
Forecasting of the aggregate demand based on seasonal forecasting (for A, category products)

Periods	**A-product demand (pieces)**	**mean demand**	**seasonal factors**	**forecast for next year**
1st Q	1072080	1047958	1.023018098	1096757
2nd Q	964872	1047958	0.920716288	888373.4
3rd Q	1.200.729.6	1047958	1.14578027	1375772
4th Q	954151.2	1047958	0.910486107	868741.4

analysis	Actual	Forecast	Error	Cum	Cum abs	Cum Abs	MAD
1st Q	1072080	1096757	-24677.25	-	24677.25	24677.25	24677.25
2nd Q	964872	888373.4	76498.63	51821.38	76498.63	101175.9	50587.94
3rd Q	1200730	1375772	-175042.6	-	175042.6	276218.5	92072.84
4th Q	954151.2	868741.4	85409.75	-	85409.75	361628.3	90407.06

Table 4
Forecasting of the aggregate demand based on seasonal factors for (for B category**)**

Periods	B-Product Demand (Pieces)	Mean Demand	Seasonal Factors	Forecast For Next Year
1st Q	86400	86400	1	86400
2nd Q	96768	86400	1.12	108380.2
3rd Q	77760	86400	0.9	69984
4th Q	84672	86400	0.98	82978.56

analysis	Actual	Forecast	Error	Cum error	Cum abs error	Cum Abs	MAD
1st Q	86400	86400	0	0	0	0	0

2nd Q	96768	108380.2	-11612.6	-11612.6	11612.6	11612.16	5806.08
3rd Q	77760	69984	7776	-3836.16	7776	19388.16	6462.79
4th Q	84672	82978.56	1693.48	-2142.719	1693.48	21081.59	5270.38

Periods	B-Product Demand (Pieces)	Mean Demand	Seasonal Factors	Forecast For Next Year
1st Q	86400	86400	1	86400
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analysis	Actual	Forecast	Error	Cum error	Cum abs error	Cum Abs	MAD
1st Q	86400	86400	0	0	0	0	0
2nd Q	96768	108380.2	-11612.6	-11612.6	11612.6	11612.16	5806.08
3rd Q	77760	69984	7776	-3836.16	7776	19388.16	6462.79
4th Q	84672	82978.56	1693.48	-2142.719	1693.48	21081.59	5270.38

Table 5
Forecasting of the aggregate demand based on seasonal factors (for C category)

Periods	C-product demand s	Mean Demands	Seasonal Factors	Forecast For Next Year(Pieces)
1st Q	140904	146188	0.963854762	135811
2nd Q	125404.56	146188	0.857830739	107575.9
3rd Q	183175.2	146188	1.253011191	229520.6
4th Q	135267.84	146188	0.925300572	125163.4

analysis	Actual	Forecast	Error	Cum error	Cum abs error	Cum Abs	MAD
1st Q	140904	135811	5093.016	5093.016	5093.016	5093.016	5093.016
2nd Q	125404.6	107575.9	17828.68	22921.7	17828.68	22921.7	11460.85
3rd Q	183175.2	229520.6	-46345.4	-23423.68	46345.38	69267.07	23089.02
4th Q	135267.8	125163.4	10104.44	-13319.24	10104.44	79371.51	19842.88

As this forecasting error analysis indicated that seasonal factors have high impacts on garment products that are the way in the four quarters of the year has different demands inputs but as production plan of the company indicated that weak plan throughout the year similar plan this exposed the company for high inventory costs. In order to minimize the

4.3 Optimization of Inventory Controlling System Based the Forecasting Demand and integer programming

Integer programming: like other optimization models, integer programming is a mathematical model which has different components. These components are: define key-decision variables, setting objective functions, writing mathematical expressions for constraints, non-negativity

inventory cost, it should optimize the production plan and minimize total cost using integer programming under consideration of seasonal forecasting. So this scientific seasonal forecasting is input for optimized production plan and level of safety stock in the case company to minimize total cost indirectly to increase the profit of the company.

restriction, and solving the mathematical model using POM-QM software. Integer programming has its own step in order to solve the problem or to optimize the inventory controlling system. The aim of optimization aggregate production planning is to maximize the overall profit of the company. and to meet demand and minimize inventory costs , these steps are as follow:

Table 6
list of finished products constraints per product

Product type	Decision variables	Cost constraint for production(p)	Cost constraint for inventory(I)
Knitted garment	P1,P2,P3,P4,I1,I2,I3,I4	15,16,18, 20	1.5,1.6,1.8,2
Knitted fabric	P1,P2,P3,P4,I1,I2,I3,I4	15,16,18, 20	1.5,1.6,1.8,2
Woven garment	P1,P2,P3,P4,I1,I2,I3,I4	15,16,18, 20	1.5,1.6,1.8,2
Woven fabric	P1,P2,P3,P4,I1,I2,I3,I4	15,16,18, 20	1.5,1.6,1.8,2
Available per quarter			

Step 1: definition of decision variable

The optimum quantities of each type of product require being produce by the company for **knitted garment** products are symbolized as follow

P1= Aggregate number of production garments in the first quartile (1^{st} Q)
P2= Aggregate number of production garments in the second quartile (2^{nd} Q)
P3= Aggregate number of production garments in the third quartile (3^{rd} Q)
P4= Aggregate number of production garment in the fourth quartile (4^{th} Q) and the second constraint is inventory capacity which symbolized as follow
I1= Aggregate number of inventory garment in the first quartile (1^{st} Q)
I2= Aggregate number of inventory garment in the second quartile (2^{nd} Q)
I3= aggregate number of inventory in the third quartile (3^{rd}Q)
I4= Aggregate number of inventory knitted garment in the first quartile (4^{th} Q),

Step2: setting the objective function

The objective function is to minimize total cost of the company and it can express as follow:

Minimize Z = 12p1+14p2+15p3+16P4 +1.2I1+1.4I2+1.5I3+1.6I4

Step 3: list of the constraint:

Resource constraint per unit of each product from the table indicated as the coefficient of the decision variables. In the formula less than or equal to inequalities signs are used to reflects the fact that inventory and production cost can only be less or equal to cost availabilities. The right hand side constrains shows production availability.

Each P1, P2, P3, P4 <= capacity production
Each I1, I2, I3 <= capacity inventory, I4 = 0
In hand inventory + P1- demand (1^{st} Q) = I1

I1 + P2- demand (2^{nd} Q) = I2

I2 +P3 – demand (3^{rd} Q) = I3, I3 +P4 –demand (4^{th} Q) = I4 (or =0), and all variables > = 0 & integer (+ve)

Step 4: the non-negativity restrictions

Objective function: Minimize Z = 12p1+14p2+15p3+16P4 +1.2I1+1.4I2+1.5I3+1.6I4

Z = total cost of production and inventory of the company

RHS = right hand side constraints

Table 7
Mathematically modeling for optimization using POM -software (for A, category products)

POM-QM software	P1	P2	P3	P4	I1	I2	I3	I4	sign	RHS	Equation form
Constraints	11	13	15	17	1.1	1.3	1.5	1.7			Min 11P1 + 13P2 + 15P3 + 17P4 + 1.1I1 + 1.3I2 + 1.5I3 + 1.7I4
Production Constraint 1	1	0	0	0	0	0	0	0	<=	1096989	P1 <= 1096989
Production Constraint 2	0	1	0	0	0	0	0	0	<=	1096989	P2 <= 1096989
Production Constraint 3	0	0	1	0	0	0	0	0	<=	1096989	P3 <= 1096989
Production Constraint 4	0	0	0	1	0	0	0	0	<=	1096989	P4 <= 1096989
Inventory Constraint 5	1	0	0	0	-1	0	0	0	=	1062080	P1 - I1 = 1062080
Inventory Constraint 6	0	1	0	0	1	-1	0	0	=	964872	P2 + I1 - I2 = 964872
Inventory Constraint 7	0	0	1	0	0	1	-1	0	=	1200730	P3 + I2 - I3 = 1200730
Inventory Constraint 8	0	0	0	1	0	0	1	-1	=	954152	P4 + I3 - I4 = 954152

Table 8
Optimal value or solution using POM -software (for A, category products)

solution	P1	P2	P3	P4	I1	I2	I3	I4	sign	RHS
Minimize	11	13	15	17	1.1	1.3	1.5	1.7		
Production Constraint 1	1	0	0	0	0	0	0	0	<=	1096989
Production Constraint 2	0	1	0	0	0	0	0	0	<=	1096989
Production Constraint 3	0	0	1	0	0	0	0	0	<=	1096989
Production Constraint 4	0	0	0	1	0	0	0	0	<=	1096989
Inventory Constraint 5	1	0	0	0	-1	0	0	0	=	1086757
Inventory Constraint 6	0	1	0	0	1	-1	0	0	=	888374
Inventory Constraint 7	0	0	1	0	0	1	-1	0	=	1275772
Inventory Constraint 8	0	0	0	1	0	0	1	-1	=	868740
Optimal Value (Z)	**1,096,989**	**1,096,989**	**1,096,989**	**828676**	**10,232**	**21,221**	**40064**	**0**		**57,225,920 birr**

Table -8 indicated an optimized solution for A-categories of products. As the table 8 indicated that the company better to produces 1,096,989, 1,096,989, 1,096,989 and 828,676 respectively for P1, P2, P3, and P4. Also, the optimized inventory plan for A-categories products as the table -8 indicated 10,232, 21,221, 40,064, and 0 pieces respectively for I1, I2, I3, and I4. The optimized annual total cost for A-categories of products is 57,225,920 BIRR as table 8 shown. This optimal solution for the garment finished products of the case company. The optimized aggregate production plan and safety stock levels for each quarter settled as table 8 indicated; this was settled by seasonal demand forecasting and optimized using integer programming. When compared with the old system of the case study the optimized solution indicated that needs low cost if the company implemented exactly the proposed solution it will additionally get net profit, 4,219,788.8 BIRR per year for A- categories as the table indicated.

Table 9
Optimal solution for aggregate demand using POM –QM SOFTWARE (for B, category products)

solution	P1	P2	P3	P4	I1	I2	I3	I4	sign	RHS
Minimize	11	13	15	17	1.1	1.3	1.5	1.7		
Production Constraint 1	1	0	0	0	0	0	0	0	<=	96768
Production Constraint 2	0	1	0	0	0	0	0	0	<=	96768
Production Constraint 3	0	0	1	0	0	0	0	0	<=	96768
Production Constraint 4	0	0	0	1	0	0	0	0	<=	96768
Inventory Constraint 5	1	0	0	0	-1	0	0	0	=	81400
Inventory Constraint 6	0	1	0	0	1	-1	0	0	=	108380
Inventory Constraint 7	0	0	1	0	0	1	-1	0	=	69984
Inventory Constraint 8	0	0	0	1	0	0	1	-1	=	82979
Optimal Value (Z)	96768	96768	96768	52439	15368	3756	30540	0		4,733,013

The above-optimized table 9 indicated 96,768, 96,768, 96,768, and 52,439 optimized production plans for B-categories products respectively for P1, P2, P3, and P4 based on the optimized solution. Also, this table indicated that 15,368, 3,756, 30,540, and 0 safety stock levels are needed for the case company based on the optimization of integer programming. The optimization of the production planning and inventory planning annual total cost needs 4,733,013, BIRR for, B- categories products . This optimized solution was conducted based on seasonal forecasting and integer programming. When compares this optimized with the old plan the cost is low. The optimized solution indicated that if the company implemented exactly the proposed solution it will get an additional, 772,055.8 BIRR per year from B-categories products only.

Table 10
Optimal solution for aggregate demand using POM –QM SOFTWARE (for c, categories products)

solutions	P1	P2	P3	P4	I1	I2	I3	I4	ign	RHS
Minimize	11	13	15	17	1.1	1.3	1.5	1.7		
Production Constraint 1	1	0	0	0	0	0	0	0	<=	183489
Production Constraint 2	0	1	0	0	0	0	0	0	<=	183489
Production Constraint 3	0	0	1	0	0	0	0	0	<=	183489
Production Constraint 4	0	0	0	1	0	0	0	0	<=	183489
Inventory Constraint 5	1	0	0	0	-1	0	0	0	=	130811
Inventory Constraint 6	0	1	0	0	1	-1	0	0	=	107576
Inventory Constraint 7	0	0	1	0	0	1	-1	0	=	229521
Inventory Constraint 8	0	0	0	1	0	0	1	-1	=	125164
Optimal Value (Z)	183489	183489	183489	42605	52678	128591	82559	0		8,229,309

The above-optimized table 10 indicated, 183489, 183489, 183489, and 42605 optimized production plans for C-categories products respectively for P1, P2, P3, and P4 based on the optimized solution. Also, this table indicated that 52678, 128591, 82559, and 0 safety stock levels are needed for the case company based on the optimization of integer programming. As the optimization of the production planning and inventory planning annual total cost needs 8229309 BIRR for C -categories products. This optimized solution was based on seasonal forecasting and integer programming. When this compares with the old one the cost is low as the errors analysis indicated. The optimized solution indicated that if the company implemented exactly the proposed solution it will get an additional, 2,119,824.2 BIRR per year from C- categories only.

5. Conclusion

The garment sector is one of the most important export items producers of Ethiopian factories. Enterprises should work with optimum capacity to be competitive worldwide in terms of quality, cost-effectiveness, and customer satisfaction. In this context, all the production processes of the enterprise its better efficiently and effectively carried out. However, as mention above, the case study is not become productive as much as possible due to inefficient resource utilization and lack of inventory controlling system. To enhance the productivities of the garment sector this study optimized the inventory and production plan through seasonal forecasting and integer programming with POM-QM software. The development of a mathematical programming model for aggregate planning and level of safety stock to the company is not only limited to providing an optimal solution for executing a production plan but also allows to the identification of improvement strategies, such as safety stock minimum and maximum levels because safety stock is critical due to unanticipated demand. However, the appropriate level is a big issue in this study. Based on the optimized solution finding annually total cost needs for each A, B, and C – categories products are 57,225,920 BIRR 4,733,013 BIRR, 8,229,309 BIRR
, respectively for production and inventory costs. The optimized solution indicated that if the company implemented exactly the proposed solution it will get additional profit,4,219,788.8 BIRR,772,055.8 BIRR,2,119,824.2 BIRR respectively for A, B, C categories products totally around 7,111,668.8 BIRR profit per year will get. Based on this optimized solution it's better to implement the case company and other garments sectors to enhance their productivity. Finally, it is concluded that this remarkable profit increment of the case company can certainly enhance its productivity and worldwide competitiveness. This research will create further pathways for other researchers to accomplish substantial study on other garment sectors or other manufacturing industries based on local and international perspectives.

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