Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/BA08.20250298
Published: December 20, 2025

Profit Optimization of a Small Garment Manufacturing Enterprise Using Linear Programming: A Case Study

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Abstract

Bangladesh's ready-made garment (RMG) sector is known as the backbone of the country's industrial economy, which contributes more than 5%of export earnings and appoints more than four million workers. Nevertheless, many small and medium-sized initiatives in this sector still depend on experience-based decision making instead of analytical planning. This research has developed and applied a simplified liner programming (LP) model for profit optimization in a small garment factory in Narayanganj, one of the major garment production centers in Bangladesh. Using realistic fixed information, which is published in BDT, this model takes three products-T-shirts, Pants, and shirts-considering and include major production limitations: fabric availability, labor hour, machine capacity, and minimum customer demand. The purpose of the model is to maximize the margin of total contribution, which represents the next profit of the variable cost, by allocating limited resources properly. Model's coefficients and parameters are taken from the conditions of the potential small factory. The LP problem is structured and resolved using the Simplex method, which determines the amount of production, which maximizes total profits and balances the assets. The results prove that small garment factories can also significantly improve their financial effectiveness using the simple mathematical tool, which is accessible by spreadsheet software like Microsoft Excel. This study creates bridges between theoretical optimization and the real SME level decision making. Its results provide a functional structure for smaller garment producers so that they can adopt data-based production plans, which will help in competition, resource use and profit increase.

Keywords
RMG, SME, Linear Programming, Resource Optimization, Profit Maximization.

1. Introduction
1.1 Background and Overview
The ready-made garment (RMG) industry is a fundamental pillar of economic transformation and industrialization of Bangladesh. The contribution of about 5% of the total export earnings of the nation works in this sector more than 1.5 million workers, most of them women, which has become an important driving force for social and economic inclusion (Majumder & Ferdaus, 2020). Narayanganj, is one of the first and liveliest centers of RMG production in Bangladesh. Despite the historical importance, most of Narayanganj factories act as small or medium-sized initiatives, which are facing serious challenges in resources optimization, production planning, and cost management (Khatun et al., 2025).

These SMES usually depend on the messy, experienced decision-making, which is replaced by the structured analytical model. As a result, they often use inadequate use of materials, labor unrest, and inadequate production of production. In the market of growing competitive global clothing, where the cost, quality and speed are very important, this type of innocence can significantly reduce profitability (Chipo et al., 2018). Large factohas in Dhaka, Gazipur, or Chittagong, where the Enterprise Resource Planning (ERP) system and Operation Research Technology have already begun to use research technology, smallest organizations are deprived of the knowledge, equipment, or financial capabilities needed to adopt these systems (Khan et al., 2022).

Linar Programming (LP), a basic technology of Operation Research, provides a scientifically -based but easy way to calculate production decisions. LP gives the manager the opportunity to determine the best production amount for multiple products, considering limited resources such as raw materials, labor, machine hours and budget constraints (Vaz et al., 2024). The important thing is that LP models can easily be applied using spreadsheet software such as Microsoft Excel or Open-Source Solver, which makes them realistic for small organizations whose digital infrastructure is limited.

1.2 Problem Statement

Although RMG export of Bangladesh has gained global recognition, the difference between large exporters and small local producers is still widespread. Many small factories in Narayanganj are struggling to determine the production schedule. These types of decisions are often taken by internal feelings, instead of data-based plans, how many units of each garment will be produced, how the labor and materials available, and how the customer needs can be fulfilled without additional costs. Lack of analytical planning results in various operational problems, such as: additional or inadequate use of resources, imbalances of production line, reduction of profit, and customer dissatisfaction.

Then, a simple and effective decision-support structure is needed that small garment initiatives can be taken, so that they can determine the most profitable production mixture and use the resources efficiently. Although RMG export of Bangladesh has gained global recognition, the difference between large exporters and small local producers is still widespread. Many small factories in Narayanganj are struggling to determine the production schedule. These types of decisions are often taken by internal feelings, instead of data-based plans, how many units of each garment will be produced, how the labor and materials available, and how the customer needs can be fulfilled without additional costs. Lack of analytical planning results in various operational problems, such as: additional or inadequate use of resources, imbalances of production line, reduction of profit, and customer dissatisfaction.

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1.3 Research Objectives

The main purpose of this study is to create a simplified linar programming model, which will be used for profit optimization in a small garment factory, and it will use static data. The model is designed in such a way that it can be solved using simple computational tools such as Excel Solver's Simplex algorithm. The specific objectives of this study are:

- Identifying the main limitations to influence the production plan of the small garment factory.
- Creating a liner programming model that contributes the product to the margin on the basis of the margin.
- Three Garment Products: Applying the model for T-shirts, Pants, and shirts.

1.4 Rationale of the Study

The garment sector of Bangladesh is competing in a global market, where the cost is very important to reduce optimization and lead time. Small improvement of production skills can bring significantly significant profit. However, most small factories do not have the process of making structured decisions, resulting in asymmetrical profitability.

This study presented a simple but powerful LP model to fill that gap, which is suitable for small initiatives. This method requires very little data (production coexistence, cost and resource availability), which are usually known to smaller producers. By converting this information into a mathematical model, the owners will be able to create an optimal production plan that is in line with the constraints of wealth.

In addition, Bangladeshi money (BDT) has been used so that the model can ensure local relevance and simple understanding. The results of the study are important for the policy makers, the SME assistance agencies, and local entrepreneurs, who want to improve their operational effectiveness in low cost analytical ways.

1.5 Scope and Limitations

The field of this study is limited only to small garment production units, which produce three product categories: T-shirts, Pants, and shirts. They present a realistic mixture of products usually produced in the small and medium garment workshops in Narayanganj. This research uses data fixed (otherwise not predicted), and concentrates on a single production cycle, instead of multiplication planning. The main limitations are:

- Market demand fluctuations or supply discipline late national stocustic factors have been eliminated.
- Excluding the allocation of specific permanent costs, only variable costs have been optimized.
- The use of simplified labor and machine has been estimated.

However, these limitations do not reduce the relevance of the model; Rather, it is making the model usable for non-technical decision-makers.

2. Literature Review

Liner Programming (LP) has long been recognized as the most powerful quantitative equipment for the correct allocation of narrow assets among competitive activities. The first contribution of Dantzig was established as a basis for the production plan, reduction of costs and maximum profit, which was widely used in the production environment (Dantzig, 2016). The application of LPs expands in subsequent studies to the capacity plan (Ripon et al., 2025), inventory control (Ghosh et al., 2020), Production Schedule (Junaiddin et al., 2023), profit maximization (Jain et al., 2021), and many more. In small and medium-sized production initiatives, the price of LP is in its capacity, which converts the intuitional managing decisions into a mathematical structure, which expresses the differences considered in the use of materials, labor and machinery.

The recently published literature highlights that LP is still absolutely basic for small organizations, but the most known as the most versatile analytical technology, where there is a lack of complex ERP or AI-based systems (Suraiya & Babul Hasan, 2023). Shakirullah et al. presented a study where they showed that spreadsheet-based LP models are capable of reduce raw materials in medium-sized textile mills by up to 5-12% (Shakirullah et al., 2020). The textile and apparel sector represents a multi-level production structure, such as cutting, sewing, finishing and packaging, which creates a fertile field for LP applications. Ripon et al. (2025) proposed a comprehensive LP-based cost-engineering model, which was aligned with the ARIMA forecast, for a Bangladeshi apparel enterprise. Their work has confirmed that LP can be instrumental in increasing profits by more than 20% compared to traditional scheduling. Rathi et al. (2021) applied LP for optimizing the product mix problem to an apparel plant.

Feng et al. (2022) tried to achieve optimized production and profit maximization in the textile industry. Suraiya and Babul Hasan (2023) approaches for cost minimization and resource utilization by using LP in the ready-made garments of Bangladesh. Woubante (2017) showed that application of LP in product mix optimization could increase monthly profits by 59.84%.

In Bangladesh, Islam et al. (2024) proved that LP can be helpful in optimizing the transportation logistics of garment clusters in Gazipur. Their research has shown that it is possible to reduce transportation costs by 7.5% by adjusting the shipment schedule through LP.

There are more than 4,500 registered factories in the RMG sector in Bangladesh, of which about 60% are small or medium-sized units (Haque, 2025). Das et al. (2025) indicates that, although large exporters have adopted integrated planning software, SMEs are still heavily dependent on human decisions. As a result, production results are erratic and profits fluctuate. Narayanganj, which has historically been a center of knitwear manufacturing, presents these challenges: small workshops have to provide low-cost, fast-turnaround time products, while there is a volatility of materials and a limitation of skilled workers.

There is less research on SME optimization in Bangladesh. Ripon et al. have found that less than 10% of small garment factories implement some form of quantitative planning plan (Ripon et al., 2025). Kunwar and Sapkota (2022) have suggested that simplified LP models can give faster results without special software.

The simplex algorithm is the most widely used method in solving LP problems, because it is robust and easily interpretable (Karloff, 2008; Réveillac, 2015; Nash, 2000; Mamatova & Ibrahimjonov, 2025). Senthilnathan (2014) emphasize that for small amounts of data, the built-in Simplex engine in Excel Solver is quite effective at maximizing dividends.

Alternative methods such as genetic algorithms or mixed-integer programming have also been proposed (Guzman et al., 2023; Kleinert et al., 2021), but the technical skills required for these are generally unavailable to small organizations. Similarly, MCDM based quantitative analysis also used by many research in several field (such as M. M. Islam et al., 2024; Hossen et al., 2025; Mim & Rahman, 2025; Mim et al., 2025; Rahman & Islam, 2024; Rahman et al., 2024; Miah et al., 2022; Rahman et al., 2020), but these are mainly for prioritizing decision factors. As a result, a spreadsheet-based simplex system-based LP system is the most practical solution for SME owners.

3. Research Methodology

3.1 Research Design

This study adopts a quantitative, model-based research design, which is based on the principles of LP. The method combines mathematical modelling with real operational data, collected from a small garment factory in Narayanganj, Bangladesh. The main goal is to create a static and single-period LP model, which can maximize the total profit within multiple resource constraints. This system consists of five steps:

- Problem Identification: Determining the operational challenges of small garment factories;
- Model formulation: Converting these challenges into a linear optimization framework;
- Data Parameterization: Determining numerical coefficients for costs, prices, and resources;
- Model Solution: Solving LP by Simplex Algorithm using Microsoft Excel Solver.

This framework maintains academic rigor on the one hand, while also ensuring practical applicability, which is consistent with SME-based LP studies in developing countries.

3.2 Research Setting

Narayanganj is one of the oldest industrial areas of Bangladesh and an important center of small-scale apparel and knitwear production. Factories located here typically rely on limited resources, informal production schedules, and low- to mid-priced products such as T-shirts, pants, and shirts. The production process are completely dependent on the availability of materials, labor and machines.

In such an environment, managers are repeatedly faced with the question of how to maximize profits by distributing limited resources into multiple products. LP provides an analytical method, which helps to determine the composition of the products that are used in the highest efficiency in materials, labor and machine time.

3.3 Model Development Procedure

The LP model is created in the following steps:

Step 1: Determining the decision: The number of units of production for each product is considered to be the decision variable: $x_1 = \text{T} - \text{shirts (units)}$, $x_2 = \text{ Pants (units)}$, $x_3 = \text{ Shirts (units)}$

Step 2: Determining the function: The goal is to maximize gross profit (Z), which is the sum of the contribution margin (selling price - variable cost) for each product. The contribution margin indicates how much profit and fixed costs each unit helps to cover.

Step 3: Determining the Limitations: The main limitations of small garment factories are:

- Cloth Restrictions: Total number of fabrics available (per meter unit)
- Restrictions on hours of work: Total number of hours of sewing work (in man-hours units)
- Limitations of the machine: Total machine time (in operating hours)
- Minimum Demand: The minimum quantity of customer orders for each product.

Each constraint is expressed as a linear inequality, so that the use of resources does not exceed the limit of availability.

Step 4: Data collection and analysis: Data were collected from field observations. The coefficients have been determined based on the general cost structure of small factories in Narayanganj.

3.4 Data Structure and Parameters

The data shown in Table 1 are used to create the model. These represent a one-time production period (e.g. one week). Table 2 shows the limit of available resources in one production cycle (about 1,000-1, 500 units) for a small factory. Variable costs include clothes, twine, accessories, and direct labor, but fixed costs (such as rent, management) are not included in the model.

Table 1. Product data and cost parameters

Product	T-shirt (x_1)	Gabardine Pant (x_2)	Shirt (x_3)
Selling Price (BDT/unit)	1,200	1,600	1,600
Fabric (m/unit)	1.2	1.5	1.5
Labor (hr/unit)	0.5	0.8	0.8
Machine Time (hr/unit)	0.2	0.3	0.3
Variable Cost (BDT/unit)	750	980	980
Contribution Margin (BDT)	450	620	620

Table 2. Availability of resources

Type	Total Availability	Unit
Fabric	1200	meters
Labor	800	hours
Machine Time	300	hours

3.5 Model Implementation

This LP model is implemented using Microsoft Excel Solver, as it is accessible and transparent for SME managers. Solver uses the simplex algorithm, which is a widely proven method for linear system optimization. Solver provides the optimum amount of output, the total profit, and the value on each constraint, which helps in analyzing the sensitivity of resource use.

3.6 Validity and Reliability of the Mode

This LP formulation has intrinsic validity, because all accepted assumptions (linearity, additivity, divisibility, and non-negativity) have been respected. The external validity has also been confirmed as the parameters used are derived from literature and field data. Reliability is maintained because any user can retrieve the same result in Solver or TORA software using the same parameters.

4. Model Formulation

4.1 Conceptual Overview

The LP model aims to determine an optimal production plan for a small garment factory, where three main products are produced: T-shirts, pants, and shirts. The goal is to maximize total profit, but adhere to important resource constraints such as fabrics, labor hours, and machine time.

This model adopts the concept of a single-period static planning. This type of approach is useful for small organizations whose decision-making typically depends on resources on a weekly or monthly basis. The LP model can be expressed in the following standard form:

$$\text{Maximize Z} = \sum_{i=1}^{3} c_i x_i$$

Subject to:

$$\sum_{i=1}^{3} a_{ji} x_i \leq b_j, \qquad for\ j = 1,2,3$$

Here,

x_i = quantity of product (i) to produce (decision variables)

c_i = contribution margin per unit of product (i) (in BDT)

a_{ji} = consumption of resource (j) per unit of product (i)
b_j = total availability of resource (j)
Z = total profit to be maximized

4.2 Objective Function
According to the data given in Table 1, the contribution margin per unit is: T-shirt = 450 BDT/unit, Gabardin pants = 620 BDT/unit, and Shirt = 720 BDT/unit.
So the objective function will be:

$$\text{Maximize Z} = 450x_1 + 620x_2 + 720x_3$$

It represents the combined total profit of each product.

4.3 Constraints Formulation
This model includes four key constraints: resource constraints and minimum demand.
(a) Fabric Availability Constraint: Fabric is a vital input, and its usage must not exceed the available 1200 meters. Given fabric consumption per product, the constraint is expressed as:

$$1.2x_1 + 1.5x_2 + 2x_3 \leq 1200$$

(b) Labor Hour Constraint: Labor availability is limited to 800 hours per production period. The total labor time used by all garments must remain within this limit:

$$0.5x_1 + 0.8x_2 + x_3 \leq 800$$

(c) Machine Capacity Constraint: Machine time, measured in operating hours, is restricted to 300 total hours for the planning period.

$$0.2x_1 + 0.3x_2 + 0.4x_3 \leq 300$$

(d) Minimum Demand Constraints: To maintain market relationships, the factory must meet a minimum order quantity for each product:

$$x_1 \geq 100, \quad x_2 \geq 80, \quad x_3 \geq 60$$

Additionally, non-negativity conditions ensure that negative production levels are not allowed:

$$x_1, x_2, x_3 \geq 0$$

4.4 LP Model Summary
The full mathematical LP model, combining the objective function and constraints, is:

Maximize Z=450x_1+620x_2+720x_3
Subject to:
1.2x_1+1.5x_2+2x_3≤1200 (Fabric Availability)
0.5x_1+0.8x_2+x_3≤800 (Labor Hour)
0.2x_1+0.3x_2+0.4x_3≤300 (Machine Capacity)
x_1≥100
x_2≥80
x_3≥60
x_1,x_2,x_3≥0

This formulation represents a standard LP problem, where the feasible region is formed by the intersection of the constraints and the optimal solution is found at the corner point of that region.

5. Results and Analysis
5.1 Overview of Solution Process
The LP model described in Chapter 4 is solved using Microsoft Excel Solver, where the Simplex LP algorithm is applied. Solver is configured in such a way that it can maximize the total profit Z, complying with the resource constraints. Decision Variables are: T-shirts (x_1), Pants (x_2), and Shirts (x_1).

All data coefficients (fabric usage, labor hours, machine time, and contribution margins) were entered into the Solver interface, and constraints were defined according to the model equations. Solver was instructed to assume non-negative decision variables. Solver provides very fast (<1 second) solutions, proving that this model is simple, fact-based and quickly implementable for small organizations.

5.2 Optimal Production Plan
Solver produced the optimal solution as Table 3.

Table 3. Optimal solution

Product	Optimal Quantity (units)	Contribution Margin (BDT/unit)	Total Contribution (BDT)
T-shirt (x_1)	100	450	45000
Gabardine Pant (x_2)	640	620	396800
Shirt (x_3)	60	720	43200
Total Profit (Z)			**485000**

Thus, the maximum achievable profit (Z) within the available resources equals 485000 BDT, and the model recommends producing 500 T-shirts, 320 Pants, and 180 Shirts during the production period. This mix fully utilizes available fabric and labor hours, while leaving a small portion of machine time unused, indicating that fabric and labor are the most binding constraints.

5.3 Verification of Resource Utilization

(a) Fabric Availability Constraint:

$$1.2 \times 100 + 1.5 \times 640 + 2 \times 60 \leq 1200$$

(b) Labor Hour Constraint:

$$0.5 \times 100 + 0.8 \times 640 + \times 60 \leq 800$$

(c) Machine Capacity Constraint:

$$0.2 \times 100 + 0.3 \times 640 + 0.4 \times 60 \leq 300$$

(d) Minimum Demand Constraints:

$$100 \geq 100, \qquad 640 \geq 80, \qquad 60 \geq 60$$

So this optimal solution meets all the constraints.

5.4 Comparative Analysis
For the comparative analysis, the optimal solution was contrasted with a baseline scenario in which production was equally allocated (250 units for each). The comparative analysis and improvement are as shown in Table 4.

Table 4. Comparative analysis

	T-shirt	Gabardine Pant	Shirt	Total Profit (BDT)
Non-optimized	250	250	250	447500
LP-optimized	100	640	60	485000
Improvement				8.38%

Thus, this LP model increases profit by approximately 8.38% compared to the non-optimized baseline scenario, where the production rate is equal for each item.

6. Discussion
The results of the LP model clearly show that optimization techniques are capable of greatly improving profit margins in small RMG manufacturing environments. Focusing on the allocation of limited resources, particularly the timing of fabrics, labor hours, and machinery, this model provided a logical and structured approach to production planning. The optimized solution proves that significant financial improvements are possible compared to the traditional intuition-based approach through analytical planning. This result supports a broader concept within the RMG sector in Bangladesh, especially for small and medium-sized enterprises, which generally do not have a formal analytical framework.

The results clearly show that, despite limited data access, small organizations can achieve significant performance improvements by using basic optimization methods. The model generated a maximum profit of 485000 BDT, which reflects an increase of about 8.38% compared to the non-optimized production allocation. Among the constraints, the availability of fabrics has emerged as the most important limiting factor, ensuring that raw material management

is the main determinant of profitability in small garment operations. In contrast, labor and machine capabilities were not fully utilized, reflecting the need for better coordination between material supply and production schedules.
The results make it clear that the availability of fabrics is the most severe constraint on the production process, which means that the profitability potential of small garment enterprises is largely dependent on the supply of material (fabrics). Since it typically accounts for 55-65% of total variable costs, its effective use has an outstanding impact on overall profit. The results of the LP model reinforce this important managerial approach, which indicates that optimizing the use of fabrics should be the main operational priority for small-scale garment manufacturers.

On the other hand, the use of labor and machine time was less in the available solution space. This result challenges the prevailing perception among small factory owners that staff shortages and machine outages are their main impediments. Rather, the model shows that when the limitation of fabrics predominates, excess labor power depreciates on the gain. From a management point of view, this implies that operational efficiency is not just about increasing the speed of production or the use of machinery, but also about matching the availability of resources with the most limited components.

From a management perspective, this research provides important guidance in terms of practical applications beyond theoretical optimization. The LP model shows that a tool such as Excel Solver, which is familiar and easy to obtain for most SME managers, can be used to reproduce these results, with very little technical training. This result is important in the context of developing countries. Thus, implementing LP models using simple spreadsheet interfaces creates analytical decision-making opportunities for SME operators and enables them to make profit-maximizing decisions without high computational efficiency.

From a theoretical point of view, this study builds a bridge to the theory of operations research and its implementation in the SME environment of developing economies. The success of a static LP model in this study shows that meaningful optimization is still possible within data constraints, limited resources, and informal organizational structures. This emphasizes the effectiveness of simple operations research in small-scale production. Therefore, the present study contributes to the theoretical discussion, proving that simplicity increases usability, especially in less automated industries.

Once SMEs are familiar with static LP models, they can gradually transition to more advanced methods, such as multi-stage or stochastic programming. When combined with enterprise resource planning (ERP) systems, it can enable automated data feeding and real-time optimization. Step by step towards Industry 4.0 and 5.0 paradigms on this path.

7. Conclusion

This study demonstrated that LP provides a practical and highly effective method of profit optimization for small garment factories in Bangladesh, especially in the Narayanganj industrial cluster. By creating and implementing a simplified LP model based on real operational data, the study provided a structured framework for determining the most profitable production mix within the constraints.

The significance of these results is not limited to computational results. They highlight the transformational potential of quantitative decision-making for RMG SMEs in Bangladesh, which has traditionally been driven by managerial assumptions. The LP model serves as a low-cost analytical tool that can be implemented in Microsoft Excel Solver, a software that is available to most factory owners. This accessibility eliminates the need for advanced technological infrastructure, making optimization implementable and scalable in the SME context. So, research has created an important bridge between academic modeling techniques and real industry decision making.

From a broader industry perspective, this study provides valuable insight into the strategic role of optimization in improving the competitiveness of small-scale garment enterprises. By incorporating LP-based methods into day-to-day operations, small factories can be transformed into systematic production plans similar to large export-oriented units. Moreover, the results indicate that such adoption can support national goals, such as the Industrial Policy 2022 in Bangladesh, which emphasizes digital transformation and green manufacturing. The LP structure, although mathematically simple, embodies the principles of Lean Manufacturing and Resource Efficiency.

The research supports broader economic and sustainability goals. Optimizing the use of fabrics reduces raw material waste, energy costs and production-related carbon emissions - which is aligned with SDG 12: Responsible Consumption and Production. In the context of Narayanganj garment cluster, where small units often operate under limited supervision, introducing optimization-based planning can effectively reduce material waste and environmental footprint.

From an academic perspective, this research makes a valuable contribution to the range of knowledge in operations research and industrial engineering, which has contextualized LP in a developing economy environment. It has proven that classic optimization tools are still relevant and effective in adapting to local realities. By simplifying the concepts of the model and using static, single-phase data, the study showed that mathematical programming is capable of generating managerial insights even in data-critical environments. This practical approach reiterates the importance of adapting analytical tools to the capabilities of the user, and highlights the need for convenient adaptations between them, rather than imposing complex methods.

However, the study identified some opportunities for future development. Although the current model is based on a deterministic and single-stage environment, future studies may expand this framework in a few aspects. First, adopting a multi-stage LP model can take into account seasonal changes in demand, price fluctuations, and inventory carry-over. Second, incorporating stochastic programming or fuzzy optimization will allow for the detection of supply chain uncertainties - such as delivery delays or power outages. Thirdly, expanding the model to multi-objective optimization will allow to equate profitability with sustainability indicators such as textile waste, carbon emissions or energy efficiency. Such extensions will bring the analysis closer to the real complexity, but will maintain the computational effectiveness.

In addition, the connection of LP models to digital technologies - such as enterprise resource planning (ERP) power BI dashboards or cloud-based decision support systems - can be instrumental in enhancing automation and real-time analytics in small garment enterprises. This digital integration will form the basis of a smart manufacturing environment, which is aligned with the principles of Industry 4.0 and Industry 5.0. By embedding optimization logic within existing operational data systems, SMEs can transition from static planning to adaptive, data-driven decision-making, which will increase their ability to respond to market changes.

Additionally, future collaborative research between universities and industry organizations can accelerate. Joint pilot projects can demonstrate the measurable impact of LP-based equipment on production efficiency, sustainable performance and profitability. Promoting such case evidence can inspire more small factories to adopt analytical approaches, helping to create a culture of evidence-based industry management in the RMG sector of Bangladesh.
Lastly, this study proved that linear programming is accessible and transformative for small garment manufacturers. It has proven that optimization is not only limited to large corporations, but it also enables resource-constrained organizations to make smarter, profitable, and sustainable decisions.

It can provide power. For Bangladesh, where the RMG sector is still playing the role of an economic driver, the inclusion of LP-based models in day-to-day production planning can make an important shift towards smart, environmentally friendly and competitive industrial growth.

Acknowledgement

The authors would like to express sincere gratitude to the members of ‘Center for IE & Management Research’ for their valuable assistance in data collection and field coordination during the study. Their cooperation greatly contributed to the accuracy and relevance of the model parameters used in this research.

References

Chipo, C., Walter, C., and Rufaro, K., Staying competitive in the fast-fashion era in a developing economy, *International Journal of Costume and Fashion*, vol. 18, no. 2, pp. 1–12, 2018.

Dantzig, G. B., *Linear programming and extensions*, Princeton University Press, 2016.

Das, R. C., Iqbal, S. M. Z., Hasan, S., Sharma, J., and Halimuzzaman, N. M., Enhancing profitability with ERP system integration in RMG industry, *International Journal of Business Management and Economic Review*, vol. 8, no. 2, pp. 90–102, 2025.

Feng, Z., Wang, R., Huang, X., Jiang, X., and Liu, Y., Analyzing textile industry by linear programming, in *Advances in Economics, Business and Management Research*, pp. 1459–1463, 2022.

Guzman, E., Poler, R., and Andres, B., A matheuristic approach combining genetic algorithm and mixed integer linear programming model for production and distribution planning in the supply chain, *Advances in Production Engineering & Management*, vol. 18, no. 1, pp. 19–31, 2023.

Haque, A., RMG industry in Bangladesh: Insights and trends, ReCom Consulting Limited, 2025.

Hossen, M. L., Rahman, M., Ifty, M. S., and Nahar, K., Identifying the barriers of implementing sustainable supply chain management: A case study on a sugar mill, *SciEn Conference Series Engineering*, vol. 3, pp. 286–291, 2025.

Islam, M. M., Rahman, M., and Arakawa, M., A hybrid MCDM approach for addressing challenges and strategies for Industry 4.0 adaptation in electronic industries of Bangladesh, *SSRN Electronic Journal*, 2024.

Islam, S., Biswas, H. R., Khatun, U. H., Rani, R., and Nourin, S. I., Optimizing transportation logistics for cost efficiency in a garment factory: A linear programming approach using LINDO, *Scholars Journal of Physics, Mathematics and Statistics*, vol. 11, no. 10, pp. 146–149, 2024.

Jain, A. K., Chouhan, S., Mishra, R. K., Choudhry, P., Saxena, H., and Bhardwaj, R., Application of linear programming in small mechanical based industry for profit maximization, *Materials Today: Proceedings*, vol. 47, pp. 6701–6703, 2021.

Junaiddin, A., Syaifuddin, D. T., Montundu, Y., and Zaid, S., The application of linear programming into production scheduling at an electrical panel company, *International Journal of Membrane Science and Technology*, vol. 10, no. 3, pp. 354–371, 2023.

Karloff, H., The simplex algorithm, in *Birkhäuser Boston eBooks*, pp. 23–47, 2008.

Khan, M. S. A., Mukit, S. H., Are small and medium enterprises (SMEs) in Bangladesh adapting ICT at a good pace? Challenges and way forward, *International Journal of SME Development*, no. 5, 2022.

Khatun, F., Kamal, M., Kabir, F. A., and Nawrin, N., Navigating the textile and readymade garments sector towards green transition: The experience in Bangladesh, Centre for Policy Dialogue, 2025.

Kleinert, T., Labbé, M., Ljubić, I., and Schmidt, M., A survey on mixed-integer programming techniques in bilevel optimization, *EURO Journal on Computational Optimization*, vol. 9, p. 100007, 2021.

Kunwar, R., and Sapkota, H. P., Introduction to linear programming problems with some real-life applications, *European Journal of Mathematics and Statistics*, vol. 3, no. 2, pp. 21–27, 2022.

Majumder, S. C., and Ferdaus, J., Contribution of ready-made garments industry to the economic development of Bangladesh: An empirical analysis, *The Economics and Finance Letters*, vol. 7, no. 2, pp. 295–307, 2020.

Mamatova, Z., and Ibrahimjonov, M., Solving linear programming problems using the simplex method: Theoretical basis and practical application, *International Journal of Artificial Intelligence*, 2025.

Miah, S., Rahman, M., and Sarkar, M. R., Finding the motivational factors influencing employee performance: A case study on NGO workers of Bangladesh, in *Proc. Int. Conf. Mechanical, Industrial and Materials Engineering*, 2022.

Mim, J. F., Islam, M. M., and Raza, A. H., A hybrid MCDM approach for unveiling ChatGPT's effect on students' learning, *Computers and Education: Artificial Intelligence*, vol. 9, p. 100457, 2025.

Mim, J. F., and Rahman, M., Assessing the development barriers for f-commerce circular supply chain using best–worst method, *Journal of Future Sustainability*, vol. 6, no. 1, pp. 15–22, 2025.

Nash, J., The (Dantzig) simplex method for linear programming, *Computing in Science & Engineering*, vol. 2, no. 1, pp. 29–31, 2000.

Rahman, M., and Islam, M. M., Digital transformation of supply chain management by adopting Industry 4.0 technology in Bangladesh: An integrated novel MCDM approach, in *Proc. 7th IEOM Bangladesh Int. Conf. Industrial Engineering and Operations Management*, 2024.

Rahman, M., Sakib, M. I., Mim, A. F., and Sarker, S., Barriers of implementing green supply chain management: Bangladesh perspective, 2020.

Rahman, M., Sarker, S., and Chowdhury, R. A., An MCGDM approach for addressing challenges for Industry 4.0 adaptation in heavy-duty flooring solution industries of Bangladesh, in *Proc. 7th IEOM Bangladesh Int. Conf. Industrial Engineering and Operations Management*, 2024.

Rathi, V., Gupta, S., and Srivastav, S., Application for optimizing the product mix problem of linear programming in the apparel industry: A case study, *Journal of University of Shanghai for Science and Technology*, vol. 23, no. 7, pp. 1091–1098, 2021.

Réveillac, J., Linear programming, in *Elsevier eBooks*, pp. 209–237, 2015.

Ripon, M. B. B., Tondra, M. R. J., Hasan, K. M. J., Sarkar, M. R., and Hossain, M. S., A linear programming-based cost engineering model for profit maximization in an apparel industry in Bangladesh, *Journal of Future Sustainability*, vol. 5, no. 4, pp. 247–260, 2025.

Senthilnathan, S., Solving linear programming problems with the solver in MS Excel, *SSRN Electronic Journal*, 2014.

Shakirullah, F. M., Ahammad, M. U., and Uddin, M. F., Profit optimization of an apparel industry in Bangladesh by linear programming model, *American Journal of Applied Mathematics*, vol. 8, no. 4, p. 182, 2020.

Suraiya, S., and Hasan, M. B., Approaching a linear programming model for production planning of a ready-made garments industry, *Journal of Applied Mathematics & Informatics*, vol. 41, no. 1, pp. 215–228, 2023.

Vaz, L. V., Gonçalves, M. C., Dias, I. C. P., and Nara, E. O. B., Application of a production planning model based on linear programming and machine learning techniques, *ITEGAM – Journal of Engineering and Technology for Industrial Applications*, vol. 10, no. 45, 2024.

Woubante, G. W., The optimization problem of product mix and linear programming applications: A case study in the apparel industry, *Open Science Journal*, vol. 2, no. 2, 2017.

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