Stitching for Success

Predicting High Productivity in Garment Manufacturing with Logistic Regression

Abstract

This study examines the relationship between management practices and worker productivity in garment manufacturing, using data from a factory in Dhaka, Bangladesh. Through logistic regression and mediation analysis, we identify key operational factors that predict whether production teams meet daily productivity targets. The final model achieves 77.1% classification accuracy, revealing that financial incentives increase the odds of high productivity by over 18 times, while overtime exhibits diminishing returns, and task complexity significantly reduces efficiency. Contrary to conventional wisdom, incentives drive productivity directly rather than through increased work hours. These findings provide evidence-based guidance for factory managers in the $330 billion global garment industry, suggesting that strategic incentives and careful task planning may be more effective than extended work hours for improving productivity.

1 Introduction

The global garment industry employs over 99 million workers, making it one of the largest sources of industrial employment worldwide (International Labour Organization, 2024). Yet productivity in many garment factories remains low, especially in developing economies where tight margins and labor constraints prevail (ILO, 2023; ILO report on Asian garment productivity, 2021). In this context, factory managers face design choices such as incentive schemes, overtime policies, and team structuring, often without clear empirical guidance. Economic studies of labor productivity reveal that extra working hours often deliver diminishing returns: after a threshold, fatigue undermines output (Pencavel, 2014). Meanwhile, organizational psychology literature demonstrates that team cohesion and internal productivity norms correlate positively with group performance, especially in production settings (Sidorenkov & Borokhovski, 2023). These findings suggest that boosting productivity in garment factories may be more nuanced than simply increasing hours or incentives.

The *Productivity Prediction of Garment Employees* dataset (2020) from the UCI Machine Learning Repository provides a rare factory-level panel dataset, including variables such as day-of-the-week, overtime, team size, and incentive indicators. Using these data, this study asks: Do financial incentives and hours of overtime exhibit diminishing returns on productivity? If productivity is affected by financial incentives, can this change in productivity be attributed to the amount of overtime worked? The answers may guide factory leaders toward evidence-based designs that allow for financial incentives to be implemented strategically.

2 Methods

The dataset used in this project, *Productivity Prediction of Garment Employees* (2020), was sourced from the UCI Machine Learning Repository and originally collected from the industrial engineering department of a garment manufacturing factory in Dhaka, Bangladesh. The data were gathered by management researchers to examine how daily conditions, incentives, and overtime affect productivity among production teams. Each observation represents one workday for a single team, recorded through the factory's internal tracking system.

The dataset contains 1,197 observations across 15 variables describing operational and human factors. Key variables include *day of the week*, *team size*, *targeted productivity*, *actual productivity*, *overtime hours*, *incentive indicator*, and *standard minute value (smv)*, which measures task complexity. Productivity was defined as the ratio of actual output to the target output, expressed as a percentage. For this analysis, we focused on *overtime* and *incentive* as primary explanatory variables, using *team size* and *day of the week* as controls to capture scheduling and organizational differences.

Prior to analysis, incomplete entries and those with zero productivity were removed. The *incentive* variable was kept as a binary indicator for whether bonuses were given, while *overtime* was standardized to represent total extra hours beyond the scheduled shift. Because all data came from a single factory, the analysis reflects a specific industrial context rather than the entire garment sector. Still, the dataset provides a detailed, real-world view of how management practices and worker conditions interact to shape productivity outcomes.

3 Model

A logistic regression model was used to predict high productivity among garment production teams. This approach was selected because the response variable was binary, indicating whether a team met or exceeded its daily productivity target. A new binary variable called *high_productivity* was created, coded as 1 if a team's *actual_productivity* was greater than or equal to its *targeted_productivity*, and 0 otherwise. This threshold was chosen because it represents a clear, objective benchmark for successful performance in an industrial setting.

The initial logistic model included several operational predictors: *targeted_productivity*, *smv* (Standard Minute Value, a measure of task complexity), *overtime_hours*, *incentive_binary* (indicating the presence of a financial bonus), *no_of_workers*, *day* of the week, and *department* (sewing or finishing). An investigation for interaction effects, specifically between *incentive_binary* and *targeted_productivity*, was conducted to test if the effect of an incentive depended on the difficulty of the target. This interaction was found to be non-significant ($p = 0.42$) and was therefore excluded to preserve model simplicity.

To refine the model and prevent overfitting, a stepwise variable selection procedure using the Akaike Information Criterion (AIC) was utilized. This process eliminated non-significant predictors, resulting in a final, more robust model. The variables *day* and *overtime_hours* were removed during this selection. The final model retained five predictors: *targeted_productivity*, *smv*, *incentive_binary*, *no_of_workers*, and *department*.

The model's performance was evaluated by splitting the data into a training set (70%) for model building and a testing set (30%) for validation. When applied to the unseen test data, the model correctly classified 77.1% of team outcomes. The model's strong discriminatory power was confirmed by a Receiver Operating Characteristic (ROC) curve, which yielded an Area Under the Curve (AUC) of 0.759 (Figure 1).

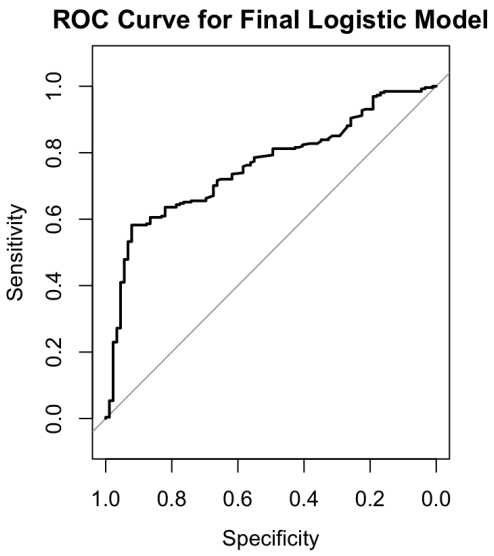

Figure 1: ROC curve

The final logistic regression model is represented by the following equation:

$$P(high\_productivity) = \frac{1}{1+e^{-(\beta 0 + \beta 1 target + \beta 2 smv + \beta 3 incentive + \beta 4 workers + \beta 5 department)}}$$

The estimated coefficients and their exponentiated values (Odds Ratios) are presented in Table 1.

Table 1: Parameter estimates for the final logistic model predicting high productivity.

Predictor	**Coefficient (β)**	**Odds Ratio**	**95% CI for Odds Ratio**	**p-value**
(Intercept)	1.159	3.187	[0.999, 10.70]	0.054
Targeted Productivity	-1.249	0.287	[0.059, 1.30]	0.112

SMV	-0.121	0.886	[0.853, 0.919]	< 0.001
Incentive (Yes)	2.909	18.33	[11.06, 31.06]	< 0.001
Number of Workers	0.059	1.060	[1.032, 1.089]	< 0.001
Department (Sewing)	-0.931	0.394	[0.132, 1.20]	0.098

4 Results

The model provides clear, actionable insights for factory management. The most substantial finding is the effect of financial incentives. Teams receiving a bonus had over 18 times the odds of achieving high productivity, underscoring the powerful role of direct financial motivation. Meanwhile, task complexity measured by Standard Minute Value significantly reduces efficiency, lowering the odds of success by approximately 11 percent per unit increase in SMV. This indicates complex garment styles require more careful planning.

The analysis also revealed a relationship between overtime and productivity. A linear model with a quadratic term showed a significant pattern of diminishing returns ($\square overtime^2 = -2.169 \times 10^{-6}$, $p = 0.025$), where initial productivity gains from overtime eventually decline, likely due to worker fatigue. Importantly, mediation analysis revealed that incentives drive productivity directly, not through increased overtime. While incentives were associated with more overtime, controlling for overtime in the model did not diminish the incentive effect. This suggests financial bonuses motivate greater intensity or efficiency during regular hours, rather than simply extending the workday.

4 Discussion

This study provides clear, data-driven answers to the questions posed at its beginning. This study confirms that both financial incentives and overtime exhibit complex relationships with productivity, as suggested by prior literature. Financial incentives produce a strong positive effect, while overtime shows statistically significant diminishing returns. Notably, the effect of incentives on productivity is direct and not mediated by overtime, meaning bonuses motivate greater focus or efficiency during regular hours, not just longer shifts. This finding aligns with principles of behavioral economics, suggesting incentive programs are a strategic investment for factory managers.

Several limitations should be noted. The study's scope is limited to one factory in Bangladesh, which may limit generalizability. The binary definition of "high productivity" simplifies a continuous outcome, and the dataset lacked nuance on team cohesion or individual skill levels. Future research could extend this work through multi-factory studies across different countries, incorporate qualitative data on team dynamics, or conduct experimental designs for stronger causal evidence. Ultimately, this study supports a shift toward evidence-based management in which strategically deploying incentives, planning for task complexity, and respecting worker limits can improve both productivity and sustainability in the garment industry.

References

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