Analyzing Productivity in Garment Manufacturing

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ABSTRACT

The production of many teams in the garment industry is examined in this report and the performance variations between departments with teams are assessed in this report using ANOVA, T-tests, and correlation analysis. Three quarters of incentive effects on productivity are examined, and productivity is evaluated by predictive modeling with polynomial regression and results provide information for raising productivity and pointing up optimal approaches to improve productivity management.

1 INTRODUCTION

The clothing industry is defined by intense competition and constant demand for higher production and efficiency and manufacturers are forced by the study and improve their manufacturing processes. Keeping a competitive advantage therefore requires an awareness of the nuances of productivity across different teams and departments.

1.1 Problem overview

Since the clothing business is so competitive and productivity improvement is essential with finding inefficiencies and helping reallocate resources to enhance performance may be accomplished by knowing the differences between departments and teams. To find trends that could direct managerial tactics this study will examine productivity statistics and look into the effects of incentives and develop prediction models.

1.2 Data Description

The dataset comprises productivity statistics from several teams and departments inside a garment manufacturing firm. The report includes data on productivity goals, actual productivity levels, incentives, and productivity trends. This information is organized by teams, departments, and days of the week. Statistical methods such as ANOVA, T-tests, and correlation analysis are employed for exploring purposes, whereas polynomial regression is utilized for predictive modeling.

2 DATA ANALYSIS

2.1 Question 1

From Table 1 , Table 2 both Actual Productivity F-statistics :10.21 and Targeted Productivity F-statistics :7.91, and the calculated their p-values are well below the significance level :0.05. Thus, reject the null hypothesis and conclude that there are significant differences in productivity between teams.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F-score
Between Teams	3.1534	11	0.2867	10.2138
Within Teams	33.2600	1185	0.0281	

Table 1: ANOVA Table for Actual Productivity

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F-score
Between Teams	0.7836	11	0.0712	7.9058
Within Teams	10.6773	1185	0.0090	

Table 2: ANOVA Table for Targeted Productivity

The investigation included average actual targeted productivity measures across several teams with The bar chart illustrate that Teams 1, 2, 3, 4, 5, and 12 exceeded their productivity goals, indicating favorable variances between their actual and intended production levels. Conversely, Teams 6, 7, 8, 9, 10, and 11 failed to meet their objectives, indicating a negative deviation

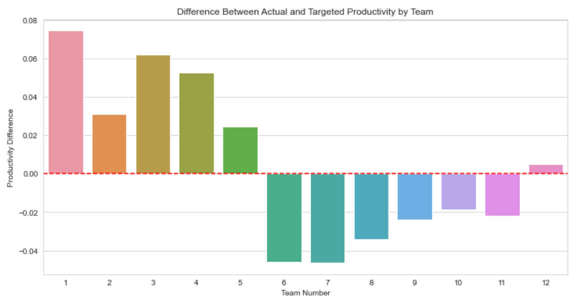

Figure 1: Difference Between Actual and Targeted Productivity by Team

In addition from the Table 3 founds the disparities indicate that Team 1 exhibited the most production with an average of roughly 0.82, while Team 7 had the lowest productivity at around 0.66.

Team	Average Actual Productivity	Average Targeted Productivity	Difference
1	0.821054	0.746667	0.074388
3	0.803880	0.742105	0.061775
4	0.770035	0.717619	0.052416
2	0.770855	0.739908	0.030947
5	0.697981	0.673656	0.024325
12	0.779055	0.774242	0.004813
10	0.719736	0.738500	-0.018764
11	0.681985	0.703977	-0.021992
9	0.734462	0.758173	-0.023711
8	0.674148	0.708257	-0.034109
6	0.685385	0.731383	-0.045998
7	0.668006	0.714271	-0.046265

Table 3: Average productivity data per team.

The consequences are crucial for management strategies, indicating that teams that continually surpass their aims might serve as exemplars of best practices, and teams falling behind should undertake additional analysis to identify obstacles to productivity, perhaps leading to the reallocation of resources or revisions to targets.In conclusion, this productivity examination offers insights into performance variability and improvement solutions. It allows a company to connect its actual outputs with its objectives and improve overall productivity management.

2.2 Question 2

This analysis assesses the garment manufacturing departments by using a T-test to compare the productivity of the sewing and finishing departments. The null hypothesis that the two departments have the same production levels will be tested against the alternative hypothesis.T-statistic: -3.041 The p-value:0.0024 rejects the null hypothesis that there is no difference in productivity between the sewing and finishing departments, as it is below the significance level of 0.05. Due to the negative t-statistic, sewing is presumably less productive than finishing

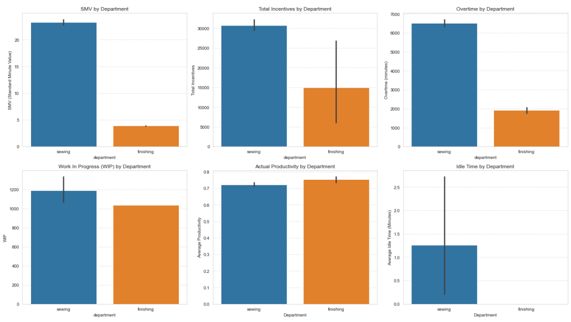

Figure 2: Bar plots display aggregate information by the department to compare sewing and finishing

and from Figure 2 it was found that the Sewing department has a higher SMV (Standard Minute Value) compared to the Finishing department. This suggests that sewing tasks generally require more time due to their complexity or the number of steps involved. The Sewing department also receives a somewhat greater overall incentive, indicating that incentives are employed more widely to enhance efficiency or tackle specific difficulties. There is a higher occurrence of overtime in the Sewing department, since workers often beyond their normal working hours. This may be attributed to increased production goals or a scarcity of manpower. The department also has a notably elevated Work in Progress (WIP) count, maybe as a result of bottlenecks or coordination challenges that impede the timely completion of tasks. Despite the presence of these incentives and the provision of overtime, the Sewing department continues to exhibit lower levels of productivity in comparison to the Finishing department, hence emphasizing the existence of possible inefficiencies in the sewing process. In addition, the Sewing department experiences increased periods of inactivity, which may be due to interruptions in production caused by insufficient materials, equipment malfunctions, or delays in preceding stages. In order to tackle these problems process optimization should prioritize the identification and elimination of bottlenecks, while using improved resource management to decrease SMV, WIP, and simplify processes. It is necessary to evaluate the incentive system in the Sewing department to verify that it is effectively designed to improve production. Implementing workload distribution strategies can effectively reduce overtime and provide a just task allocation with using these tactics, efficiency will be enhanced, overtime will be reduced, and both departments will be able to attain higher levels of production and profitability.Based on the higher values in all the analyzed measures, this indicates that sewing is more tedious than finishing.

2.3 Question 3

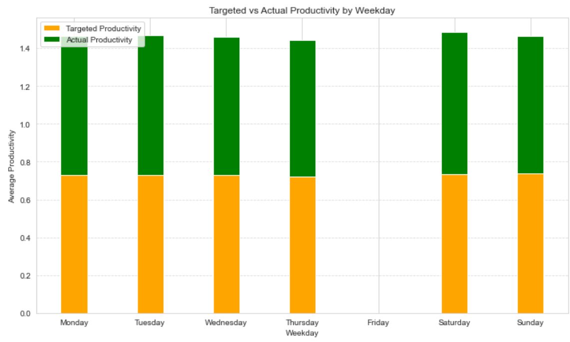

Figure 3: Targeted vs Actual Productrvity by Weekday

The analysis from the Figure 3 suggests that the workers may be resting on Friday (which is not in the dataset). This pattern aligns with other findings in the Table 4 where a rest day positively impacts productivity the day after, which is evident on Saturday productivity remains relatively consistent (slight increase afterward), implying potential benefits of a day off

Day	Average Actual Productivity	Average Targeted Productivity	Difference
Saturday	0.751929	0.733690	0.018239
Tuesday	0.742701	0.727612	0.015089
Monday	0.735488	0.729397	0.006092
Thursday	0.722641	0.720704	0.001937
Wednesday	0.730462	0.729087	0.001375
Sunday	0.728604	0.737438	-0.008834

Table 4: Average productivity data per Day.

2.4 Question 4

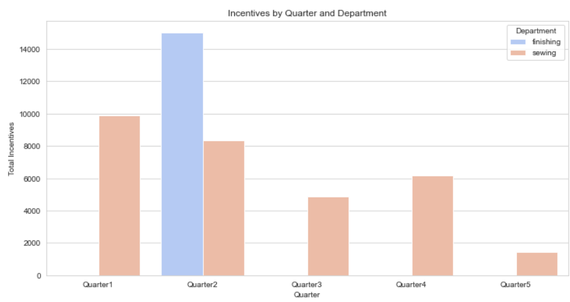

Figure 4: Incentives by Quarter and Department

Analyzing the incentive payouts it is evident found on the Table 5 show that the finishing department receives greater rewards than the sewing department, especially during Quarter 2, which stands out as the period with the most significant total payouts overall. The sewing department consistently maintains a stable level of incentives throughout the year. However, it is somewhat lower compared to other periods. However, from the Figure 4 Quarter 1 stands out as the most profitable quarter for the department. Conversely, Quarter 5 has the most minimal incentive payouts. These findings indicate that the finishing department holds more strategic importance or productivity but the sewing department should assess its operations to seek chances for development.

Date	Department	Incentive	Quarter
2015-03-09	finishing	15000	Quarter2
2015-01-31	sewing	742	Quarter5
2015-01-29	sewing	718	Quarter5
2015-01-08	sewing	691	Quarter2
2015-01-24	sewing	682	Quarter4
2015-01-07	sewing	672	Quarter1
2015-01-28	sewing	659	Quarter4
2015-01-25	sewing	656	Quarter4
2015-02-01	sewing	652	Quarter1
2015-02-03	sewing	640	Quarter1

Table 5: incentives by quarter for both departments

3 PREDICTIVE MODELLING

From the correlation matrix Figure below, it was found that there is no strong correlation between any of the elements with the target element: Actual Productivity .For this reason,linear regression cannot be used.

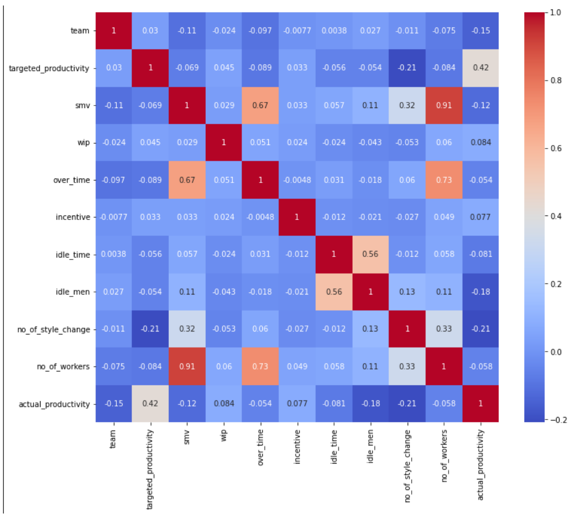

Figure 5: Correlation with dependant variable (Actual Productivity)

Following performing an analysis of polynomial degrees in predictive modeling of worker productivity from the tablit was found that Polynomial Degree 2 showed the highest level of performance among all the degrees that were analyzed. Having a Mean Squared Error (MSE) of roughly 0.0180 and a R square score of around 0.32, it achieved a good balance between prediction accuracy and complexity.

The baseline linear regression model, also known as Degree 1, had a satisfactory Mean Squared Error (MSE) of around 0.0219 and a coefficient around 0.17. Although it demonstrated steady performance, it was outperformed by the polynomial model with a higher degree. Compared to that, higher levels (3 and beyond) showed a decrease in performance, as seen by negative R square scores and extremely high MSE values. This suggests a serious issue of overfitting caused by the increased complexity of these models.

Degree	MSE	R Square
1	0.021921	0.174415
2	0.018001	0.322068
3	0.019025	0.283483
4	0.138944	-4.232798
5	0.084094	-2.167100

Table 6: degree polynomial

Polynomial Degree: 2 Mean Squared Error (MSE): 0.01800
Mean Absolute Error (MAE): 0.09085
R-squared (R^2) Score: 0.3220

Sample	Actual Productivity	Predicted Productivity
921	0.268214	0.516878
321	0.800359	0.827363
101	0.681061	0.781735
920	0.325000	0.715008
58	0.667604	0.789802
790	0.800980	0.593105
948	0.768847	0.614827
969	0.768847	0.614827
410	0.650417	0.601504
1079	0.750396	0.763044

Table 7: Actual vs Predicted Productivity polynomial.

3.1 Discussion of Results

T-Test Analysis: The T-test results point to a statistically significant difference in productivity between the sewing and finishing departments with the sewing department having less productivity and the negative T-statistic provides evidence that sewing has reduced productivity as a result of factors such as standard minute value (SMV), overtime, and increased inactivity. Although there are increased incentives, the sewing department continues to need more inefficiencies, such as production bottlenecks and coordination challenges. To overcome these issues, it is crucial to improve resource allocation and optimize task distribution.

Correlation Analysis: The correlation matrix (Figure 5) Indicates a low correlation between productivity and other characteristics. Linear regression is not suited for modeling productivity because it lacks strong relationships that are linear. Additional prediction models may be necessary to more accurately capture the trends.

Polynomial Regression Analysis: Polynomial regression models of varying degrees were tested to predict productivity. The second-degree polynomial model (Table 7) produced the best results, with an MSE of 0.01800 and an R score of 0.3220. However, higher-degree models overfit, leading to poor predictive performance. Therefore, the second-degree polynomial is the best choice, indicating that nonlinear relationships exist but are not overly complex.

Incentive Analysis: An analysis of incentive payouts (Table 5 and Figure 4) shows The finishing department gets more incentives, particularly in Quarter 2, according to an examination of incentive distributions. The sewing section is still less productive even if incentives are consistent all year round. Examining the incentive structure will help to solve certain requirements and difficulties.

Daily Productivity Analysis: Productivity data per day (Table 4) It appears that Saturday is the most productive day, perhaps because Friday is a rest day. This stability and little rise after rest point to the advantages of scheduled breaks for productivity.

4 CONCLUSION

This productivity study offers an in-depth productivity differences overview within department and garment manufacturing teams that frequently exceed expectations can be used as standards for exemplary methods, while teams that under perform require process optimization and The practice of sewing encounters difficulties associated with bottlenecks, high standard minute value (SMV) and,over time, enhanced resource allocation and job distribution. Polynomial regression is useful for predictive modeling because it determines the most suitable degrees to estimate production accurately. Ultimately, these observations can assist management in readjusting tactics and reallocating resources, and creating incentive systems to attain greater production and profitability.

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