Productivity Prediction of Garment Employees

Midega George

Introduction

The Garment Industry is one of the key examples of the industrial globalization of this modern era. It is a highly labour-intensive industry with lots of manual processes. Satisfying the huge global demand for garment products is mostly dependent on the production and delivery performance of the employees in the garment manufacturing companies. So, it is highly desirable among the decision makers in the garments industry to track, analyse and predict the productivity performance of the working teams in their factories. The goal of this project is to create a predictive multiple regression model that can help the manufacturers set an accurate target, minimize the production loss and maximize the profit.

Data Set Information

The `garments_worker_productivity` dataset can be used for regression purpose by predicting the productivity range (0-1) or for classification purpose by transforming the productivity range (0-1) into different classes. Table 1 provides attribute information for the dataset.

Table 1: Table 1: Attribute Information about `garments_worker_productivity` dataset.

Variable	**Interpretation**	**Values**
`date`	Date in MM-DD-YYYY	1/1/2015 − 3/11/2015
`day`	Day of the Week	Sunday − Thursday (Friday excluded)
`quarter`	A portion of the month. A month was divided into four quarters	Q1 − Q5
`department`	Associated department with the instance	Sewing and Finishing
`team_no`	Associated team number with the instance	1 − 12
`no_of_workers`	Number of workers in each team	2 − 89 (min − max)

Variable	Interpretation	Values
no_of_style_change	Number of changes in the style of a particular product	0 − 2
targeted_productivity	Targeted productivity set by the Authority for each team for each day	0.07 − 0.80 (min − max)
smv	Standard Minute Value, it is the allocated time for a task	2.90 − 54.56 (min − max)
wip	Work in progress. Includes the number of unfinished items for products	7 − 23122 (506 missing)
over_time	Represents the amount of overtime by each team in minutes	0 − 25920 (min − max)
incentive	Represents the amount of financial incentive (in BDT) that enables or motivates a particular course of action.	0 − 3600 (min − max)
idle_time	The amount of time when the production was interrupted due to several reasons	0 − 300 (min − max)
idle_men	The number of workers who were idle due to production interruption	0 − 45 (min − max)
actual_productivity	The actual % of productivity that was delivered by the workers. It ranges from 0-1	0.2337 − 1.1204 (min − max)

Data Inspection

The dataset has 691 complete cases and 506 missing observations in the work in progress (`wip`) variable. Therefore, these values will be filled using the predictive mean matching method. Additionally, there are some trailing spaces and misspelling of values in the `department` variable which have to be corrected. The `date` variable is also removed because it is redundant in this analysis. The following observations − `quarter, department`, and `day` − are then converted to categorical variables.

Analysis

Preliminary results from the pair plot (not shown) reveals that there are no evidence of linear relationship between the variables and the outcome variable. However, there seems to be a positive linear relationship between `no_of_workers` and `overtime`.

```
Call:
lm(formula = actual_productivity ~ ., data = employees)

Residuals:
     Min       1Q   Median       3Q      Max
-0.56178 -0.06121  0.01302  0.08324  0.51724

Coefficients:
                        Estimate Std. Error t value Pr(>|t|)
(Intercept)            3.100e-01  4.086e-02   7.587 6.69e-14 ***
quarterQuarter2        4.267e-03  1.132e-02   0.377 0.706293
quarterQuarter3       -1.271e-02  1.295e-02  -0.981 0.326628
quarterQuarter4       -1.218e-02  1.262e-02  -0.965 0.334525
quarterQuarter5        8.951e-02  2.425e-02   3.691 0.000234 ***
departmentsewing      -6.902e-02  3.358e-02  -2.055 0.040068 *
daySaturday            1.058e-02  1.540e-02   0.687 0.492122
daySunday             -2.014e-03  1.472e-02  -0.137 0.891192
dayThursday           -8.336e-03  1.506e-02  -0.553 0.580152
dayTuesday             1.766e-02  1.470e-02   1.201 0.229946
dayWednesday           2.972e-03  1.456e-02   0.204 0.838281
team2                 -3.992e-02  2.000e-02  -1.996 0.046127 *
team3                 -6.280e-03  2.071e-02  -0.303 0.761814
team4                 -2.220e-02  2.027e-02  -1.095 0.273681
team5                 -6.065e-02  2.105e-02  -2.882 0.004028 **
team6                 -9.312e-02  2.320e-02  -4.014 6.34e-05 ***
team7                 -9.988e-02  2.079e-02  -4.804 1.76e-06 ***
team8                 -9.645e-02  2.012e-02  -4.793 1.86e-06 ***
team9                 -8.836e-02  2.018e-02  -4.379 1.30e-05 ***
team10                -8.783e-02  2.042e-02  -4.301 1.84e-05 ***
team11                -1.419e-01  2.215e-02  -6.404 2.19e-10 ***
team12                -3.779e-02  2.299e-02  -1.644 0.100527
targeted_productivity  6.536e-01  4.637e-02  14.096  < 2e-16 ***
smv                   -6.890e-03  1.028e-03  -6.704 3.16e-11 ***
wip                   -1.768e-07  1.941e-06  -0.091 0.927432
over_time             -4.699e-06  2.034e-06  -2.310 0.021042 *
incentive              4.247e-05  2.701e-05   1.572 0.116227
idle_time              3.503e-04  4.058e-04   0.863 0.388149
idle_men              -8.066e-03  1.610e-03  -5.011 6.26e-07 ***
no_of_style_change1   -6.601e-02  1.699e-02  -3.885 0.000108 ***
no_of_style_change2   -4.107e-02  2.866e-02  -1.433 0.152199
no_of_workers          5.269e-03  8.708e-04   6.051 1.93e-09 ***
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```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1451 on 1165 degrees of freedom
Multiple R-squared:  0.326, Adjusted R-squared:  0.3081
F-statistic: 18.18 on 31 and 1165 DF,  p-value: < 2.2e-16
```

Acknowledgement

[1] Imran, A. A., Amin, M. N., Islam Rifat, M. R., & Mehreen, S. (2019). Deep Neural Network Approach for Predicting the Productivity of Garment Employees. 2019 6th International Conference on Control, Decision and Information Technologies (CoDIT).

[2] Rahim, M. S., Imran, A. A., & Ahmed, T. (2021). Mining the Productivity Data of Garment Industry. International Journal of Business Intelligence and Data Mining, 1(1), 1.