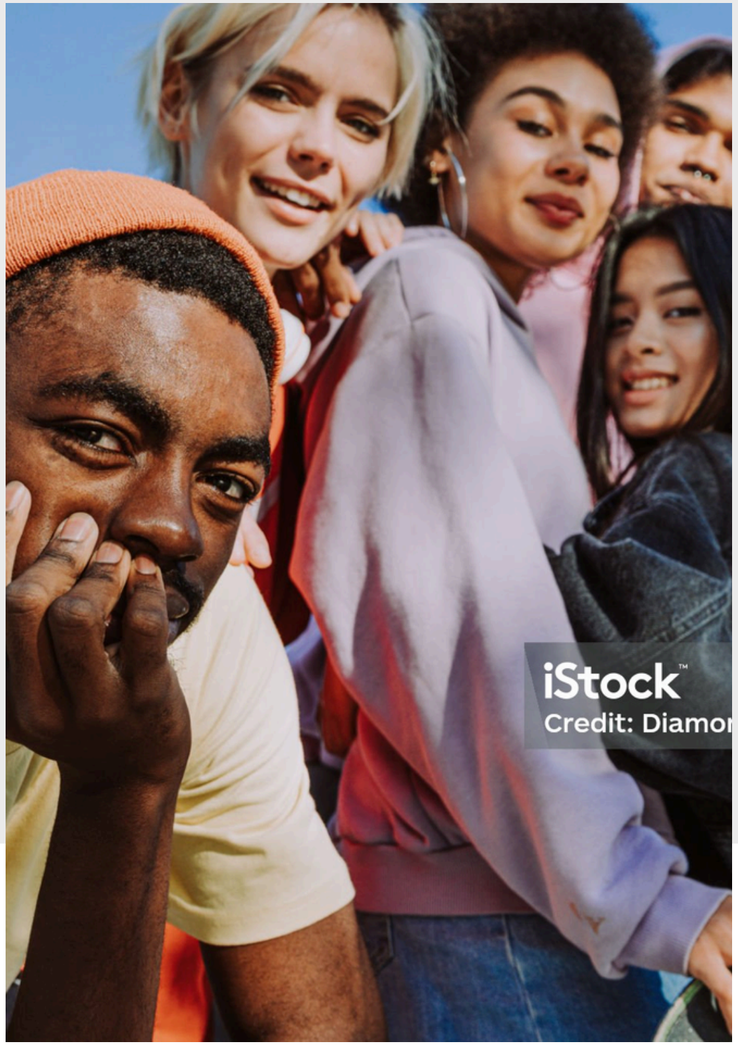
PREDICTING PRODUCTIVITY OF GARMENT EMPLOYEES

GROUP 11

In the Garment Industry Productivity is a must

Keeping costs low

Global Competition



Fast Fashion Demand

About the Dataset

15 Variables

1197 Observations

Time Related

- date
- day
- quarter
- over time

Work Force & Team

- Deparment
- Team No
- No of Workers
- Idle men
- Incentive

Production Process

- No of style changes
- Standard Minute Value
- Work in Progress
- Idle time

Productivity Metrics

- Targeted Productivity
- Actual Productivity

Sewing

Finishing

Sewing & Finishing Different Work Flows

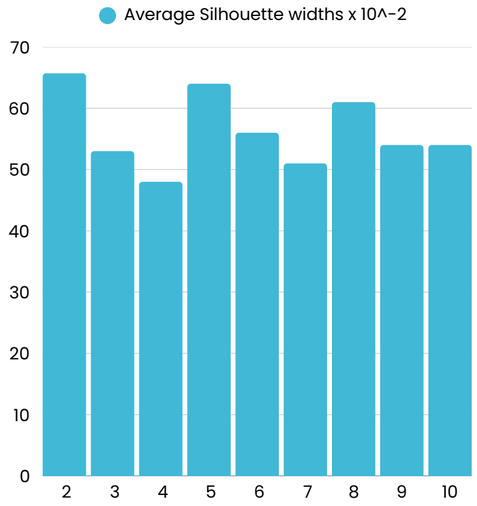
01. Sewing

Creative , dynamic, frequent style changes

02. Finishing

Standardized, consistent, final touches like pressing and packaging

SEWING AND FINISHING DEPARTMENTS ARE 2 SEPERATE CLUSTERS



K means Clustering

2 Clusters
Highest Avg Silhoutte Width

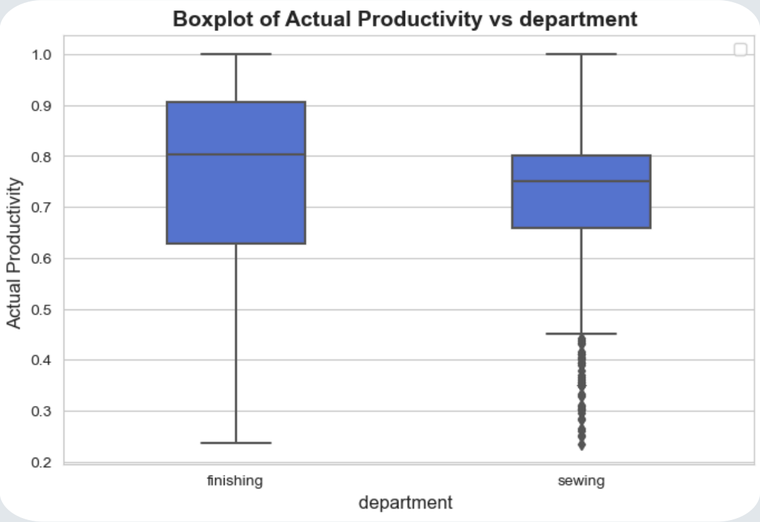
P < 0.05
Chi Square Test

significant association between **department and cluster**

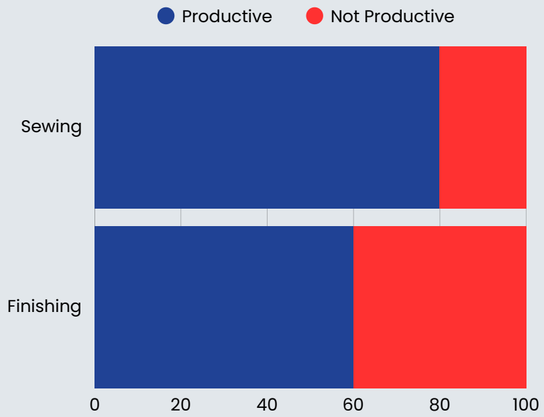
V= 0.68
Cramer's V value

Department explains a substantial portion of the variation in **clusters**

Key Insights



Finishing Department less consistent than the sewing Deparment



20% - **Not Productive** in Sewing

40% - **Not Productive** in Finishing

No Incentives
No Motivation

Lack of Task Engagement

Higher Pressure and instability

Introducing performance based rewards

Standardized Workflow & Process Optimization

Understand which teams Struggle

Sewing

Finishing

Recommendations for Improving Team Productivity

01. Sewing

- Team 5 - Underperforms despite Low Expectations

02. Finishing

- Reallocate some of Team 6, 7, and 8's workload to Team 5
- Provide training to Teams 6, 7, and 8

Liceria & Co.

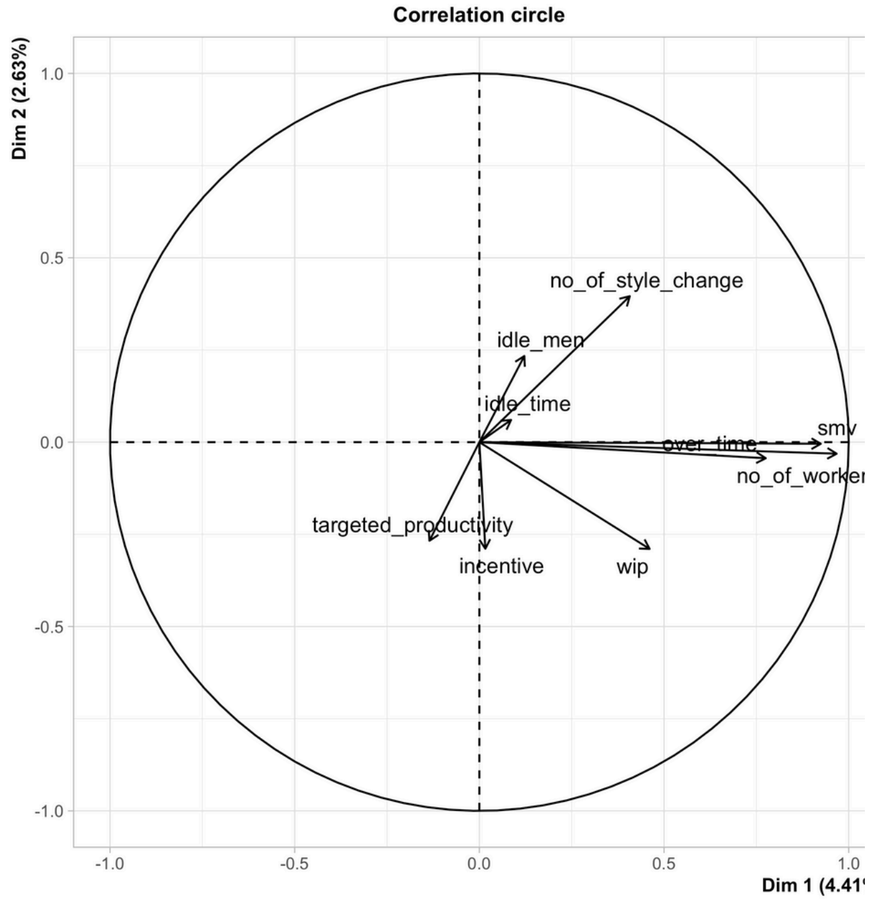
MODEL BUILDING

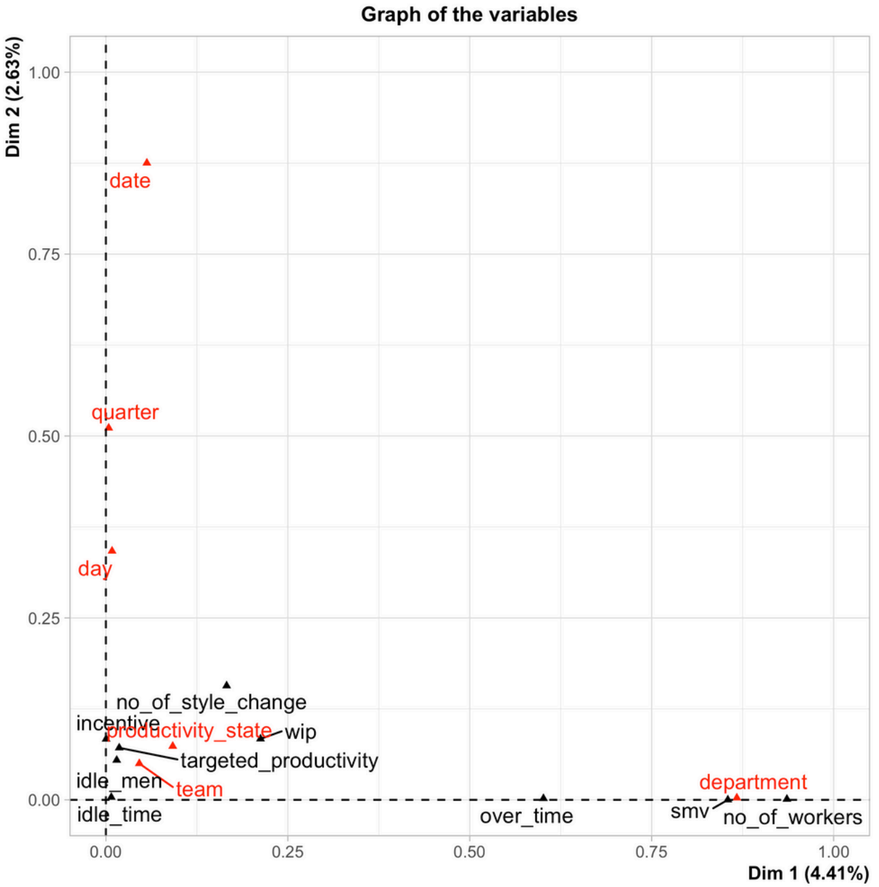
Enables Data Driven Decision Making

Presence of Multi-collinearity

- **numerical vs numerical**
  Kandels tau
- **Categorical vs Categorical**
  Pearson's chi-square test
  fisher's exact test

Factor Analysis For Mixed Data





Correlated Variable Groups

idle_time idle_men no_of_style_change	no_of_workers smv over_time	targeted_productivity no_of_style_change	targeted_productivity incentive	date quarter day

SUGGESTIONS FOR ADVANCED ANALYSIS

01. Multi Collinearity & Irrelevant Features

- **Ridge Regression**
  - Good for multicollinearity
  - No feature selection
- **Lasso Regression**
  - Has feature selection properties
  - Sometimes struggles with multicollinearity
- **Elastic Net Regression**
  - Balance between Ridge and Lasso

02. Handle Extreme Values & Non linear relationships

- **Regression Tree**
  - Handles non-linear relationships well
  - Can be sensitive to outliers
  - When multicollinearity exists, can pick one feature & ignore others
- **Random Forest**
  - Handles multicollinearity better than a single tree
  - Reduces overfitting via bagging
- **XGBoost**
  - Reduces overfitting with regularization
  - Efficient and high-performing

MODELS FOR PREDICTING ACTUAL PRODUCTIVITY OF THE GARMENT

MEASURE	RIDGE	LASSO	ELASTIC	REGRESSION TREE	RANDOM FOREST	XGBOOST
TRAIN MSE	0.0207	0.02102	0.0208	0.0153	0.0109	0.01007
TEST MSE	0.02165	0.02148	0.0215	0.0141	0.01131	0.01384
TRAIN R2	32.82%	31.96%	32.539%	50.43%	56.25%	67.40%
TEST R2	18.10%	18.73%	32.54%	46.71%	49.715%	47.61%

Shrinkage Methods

Non Linear methods

All the models show lower accuracy in predictions

“Sewing is the backbone of the Garment Production”

40 - 60 %
Total Time Spent

Of the total time spent in manufacturing the garment is for sewing

International Labor Organization

50 - 60%
Production Cost

The sewing process in garment factories accounts for up to 50 - 60% of total production costs

World bank

01.
Faster Production

02.
Lower Costs & Fewer Mistakes

03.
Better Quality & Happier Customers

ALL MODELS SHOW BETTER PERFORMANCE IN PREDICTING SEWING DEPARTMENT PRODUCTIVITY

Shrinkage Methods

MEASURE	RIDGE	LASSO	ELASTIC
TRAIN MSE	0.00453	0.00469	0.00449
TEST MSE	0.00481	0.00486	0.00475
TRAIN R2	81.57%	80.95%	82.97%
TEST R2	76.67%	76.42%	76.98%

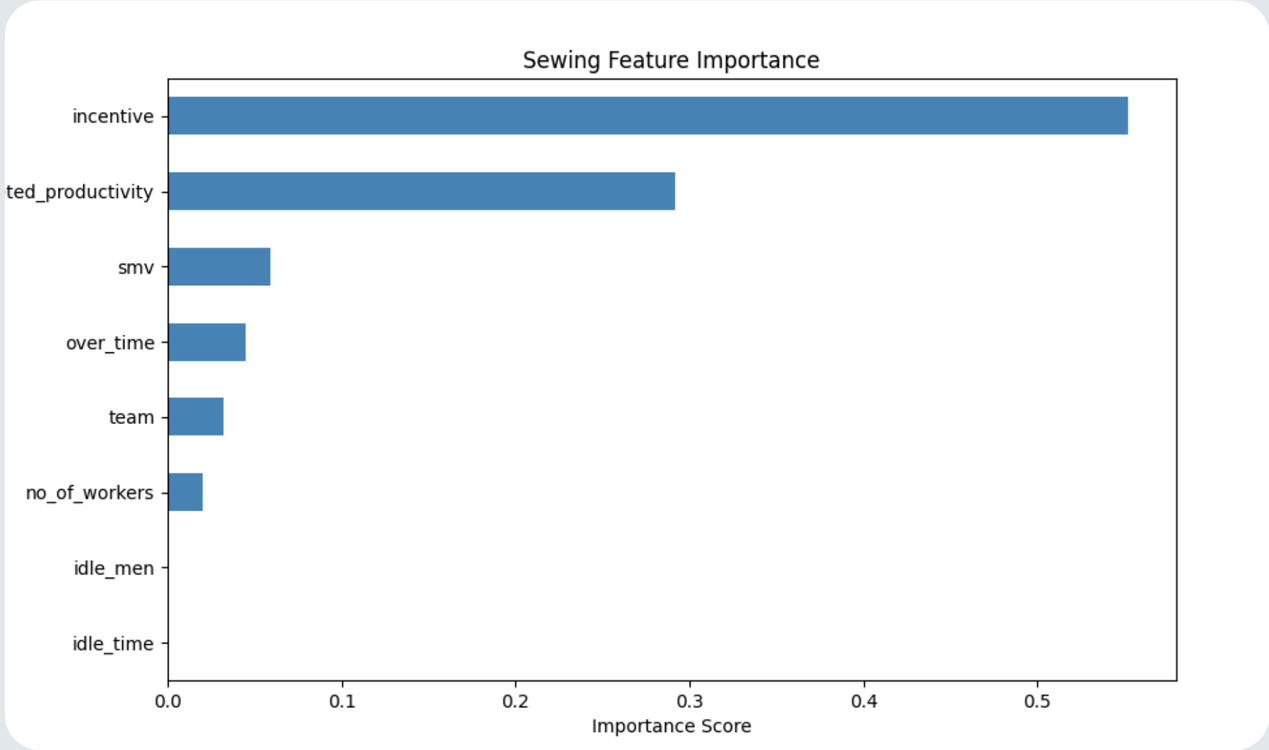
Non Linear methods

REGRESSION TREE	RANDOM FOREST	XGBOOST
0.00811	0.00194	0.00202
0.00727	0.0035	0.00415
67.07%	88.434%	91.773%
64.61%	80.70%	79.81%

Best Predictive Model — **Random Forest**

RANDOM FOREST MODEL

01. Feature Importance

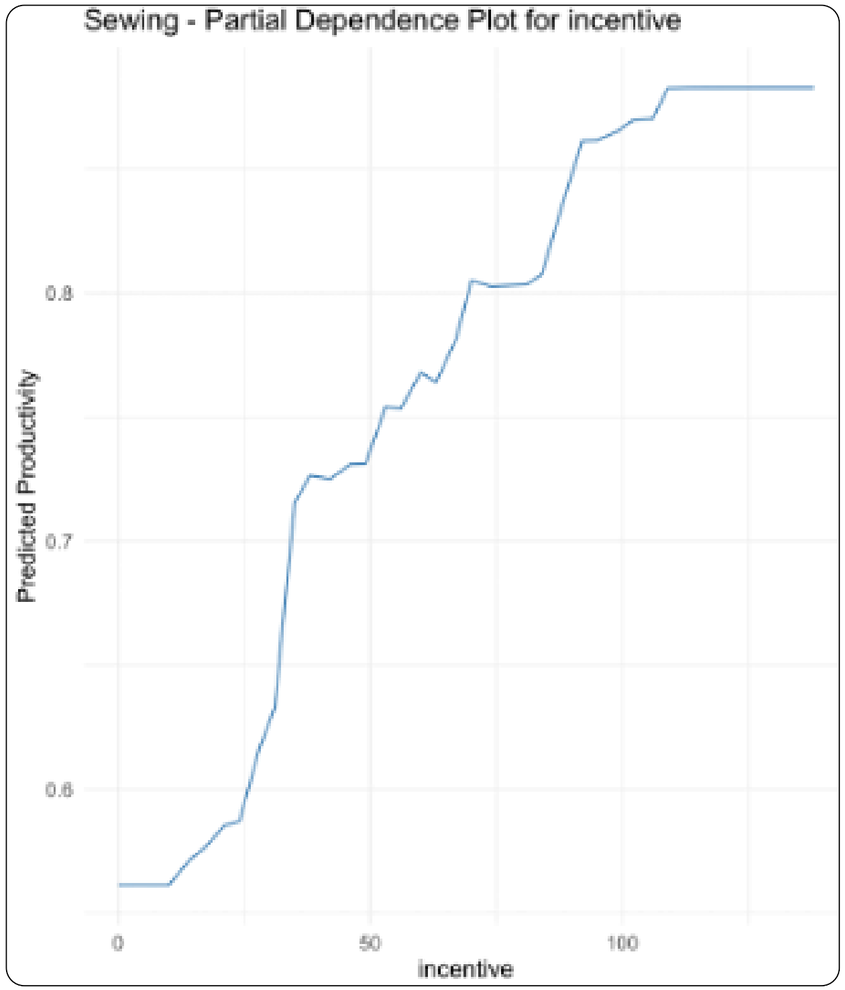


Most important Features

Incentives
Target productivity
SMV
Overtime

Parameter	Value
n_estimators	500
min_samples_split	10
min_samples_leaf	6
max_leaf_nodes	100
max_features	0.5
max_depth	None
ccp_alpha	0

Managing Incentive Allocation for peak productivity



Low Incentive Range (1-25)

minimal improvement in productivity when incentives are increased within this range. This suggests that smaller incentives may not be strong enough to significantly motivate workers.

Moderate Incentive Range (25-50)

A sharp increase in productivity is observed when incentives rise from 25 to 50. This indicates that a threshold effect exists—workers respond significantly to a higher incentive level once it crosses a certain point.

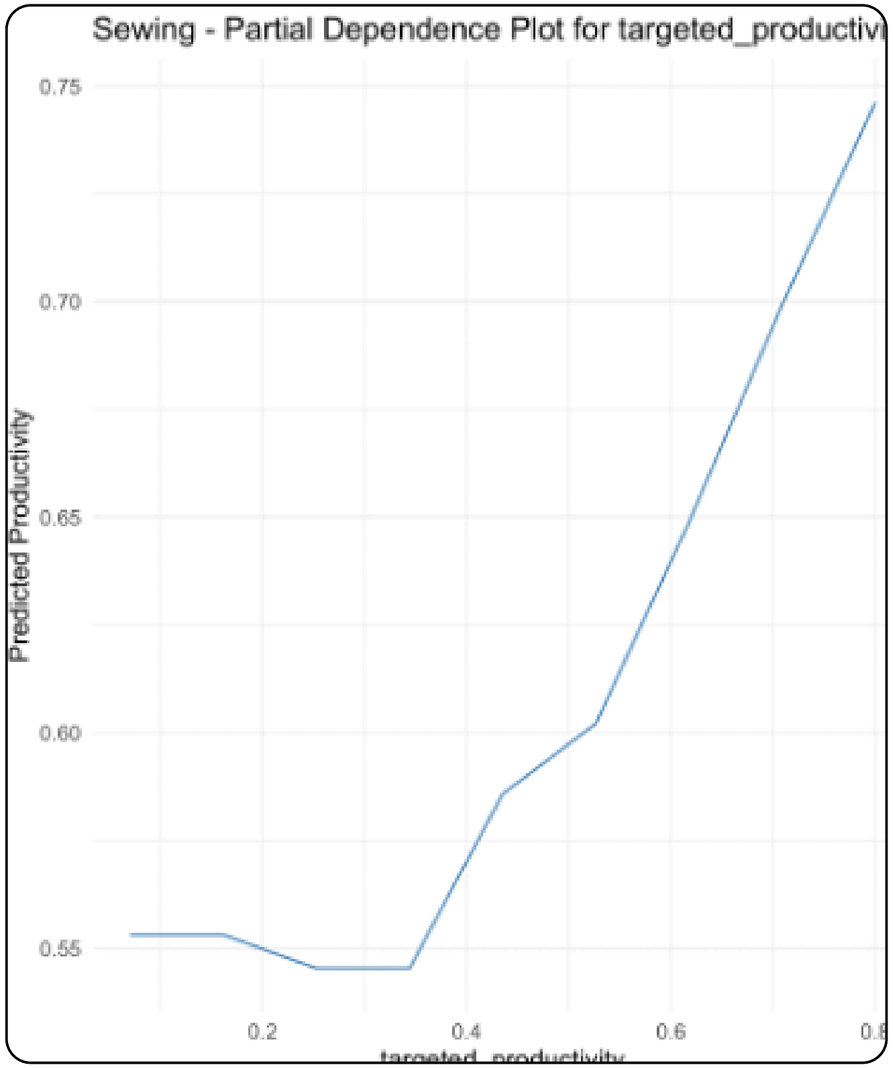
01.

Set Effective Incentive Levels

02.

Avoid Small Increments

Setting Targets for getting peak Productivity



Lower Target Productivity (Below 0.4):

Actual productivity stagnates, likely due to low motivation and unclear goals, resulting in minimal gains.

Higher Target Productivity (Above 0.4):

Once the target exceeds 0.4, actual productivity rises steadily, showing that higher benchmarks boost performance through clear goals and motivation.

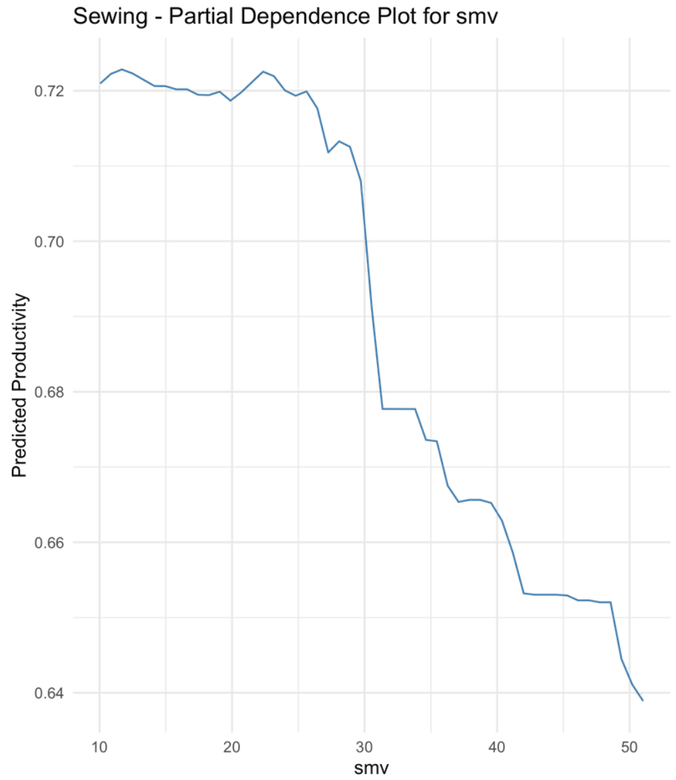
01.

Set a Minimum Target Benchmark

02.

Monitor and Adjust Goals

Optimizing the SMV of tasks for Peak productivity



Peak performance at smv Range (10-20)

simpler tasks with lower smv values are generally more efficient reaching peak performance at smv 25

Exponential Drop in SMV beyond 30

Further increase in smv beyond this point does not yield a productivity gain

Standard Minute Value = (Basic minute + Bundle allowances + machine allowance + personal fatigue allowances).

01.

Aim to keep the SMV below 30

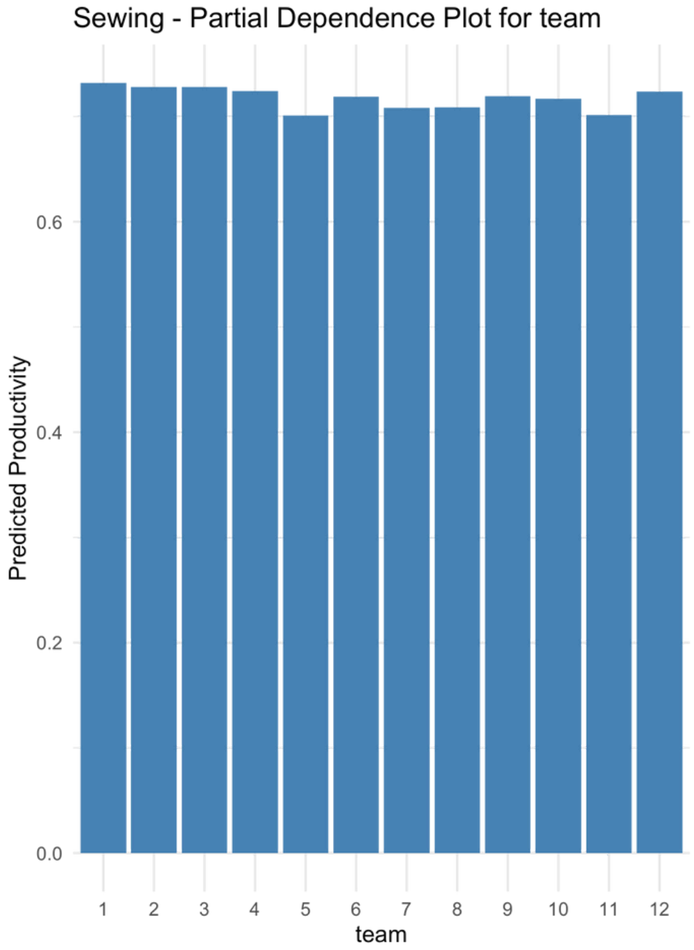
02.

Break down complex tasks into simpler sub tasks of smv around 25

03.

Targeted Training for tasks having high SMV

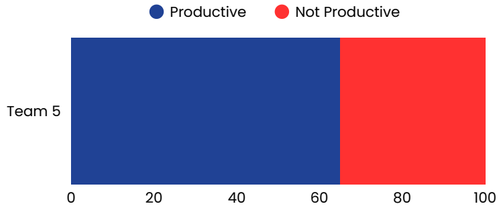
Investigating teams for optimizing productivity



Interpretation

When all other predictors are kept constant, all teams perform essentially the same

Team 5 is one of the worst performing team in sewing



35% - **Not Productive work** in Team 5

Pairwise Comparison of target productivity - Dunn's Test

P < 0.05
Dunn's Test

for team 5 with other teams

Team 5 currently has lower target productivity, but have the potential to perform as well as other teams

Gradually raising their goals and offering support, we can help them reach their full potential.

Finishing Department

"Efficiency in the finishing department is not just about speed; it’s about precision, consistency, and delivering quality that meets the expectations of the end consumer."

~ Apparel Resources

Finishing Department - Predictors

Zero Observations

- idle_time
- idle_men
- wip
- no_of_style_change

Predictors

Finishing Department

- Target Productivity
- incentives
- SMV
- Over time
- No of Workers
- Quarter
- Day
- Team

MODELS FOR PREDICTING ACTUAL PRODUCTIVITY OF THE FINISHING DEPARTMENT

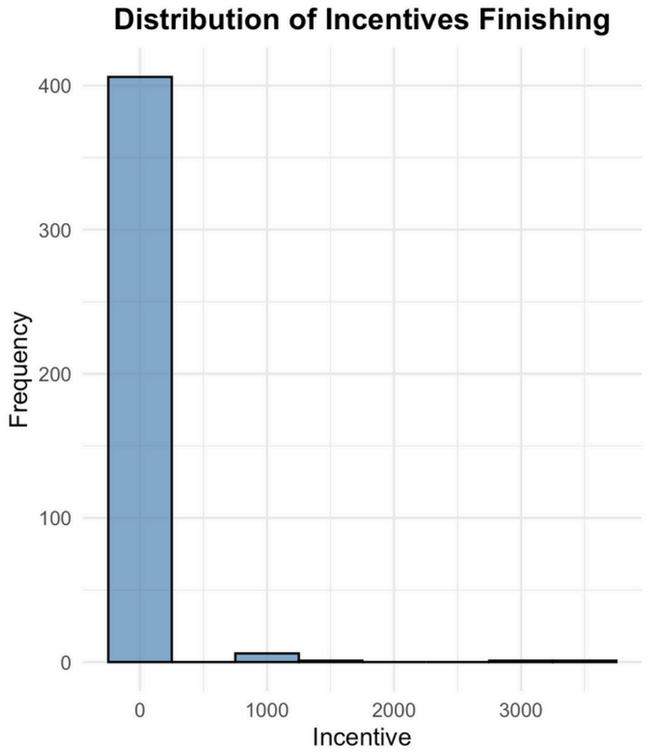
MEASURE	RIDGE	LASSO	ELASTIC	REGRESSION TREE	RANDOM FOREST	XGBOOST
TRAIN MSE	0.0308	0.0306	0.0307	0.0330	0.021	0.023
TEST MSE	0.0331	0.0326	0.0326	0.0313	0.020	0.029
TRAIN R2	20.20%	20.66%	20.52%	14.48%	43.3%	41.52%
TEST R2	5.29%	6.73%	6.78%	10.29%	26.8%	18.36%

Shrinkage Methods

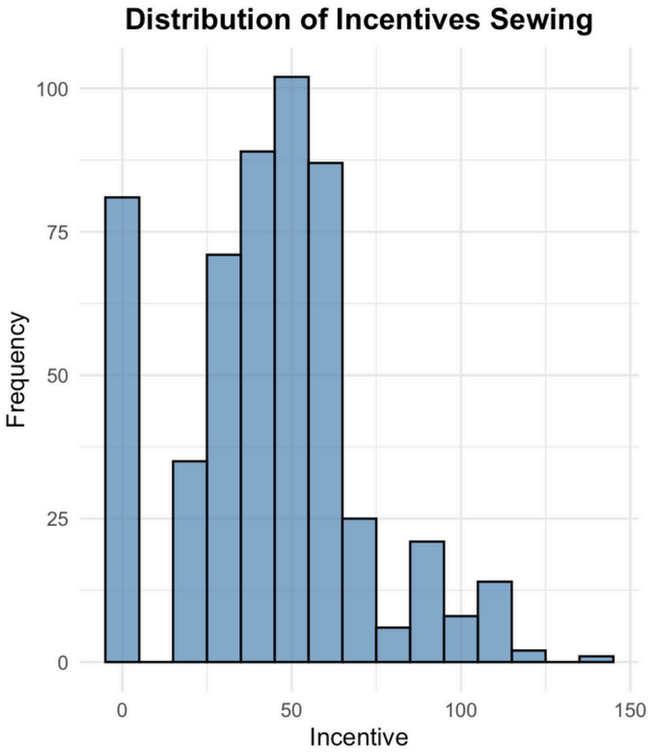
Non Linear methods

All the models show very lower accuracy in predictions

Investigating the incentives for the finishing department



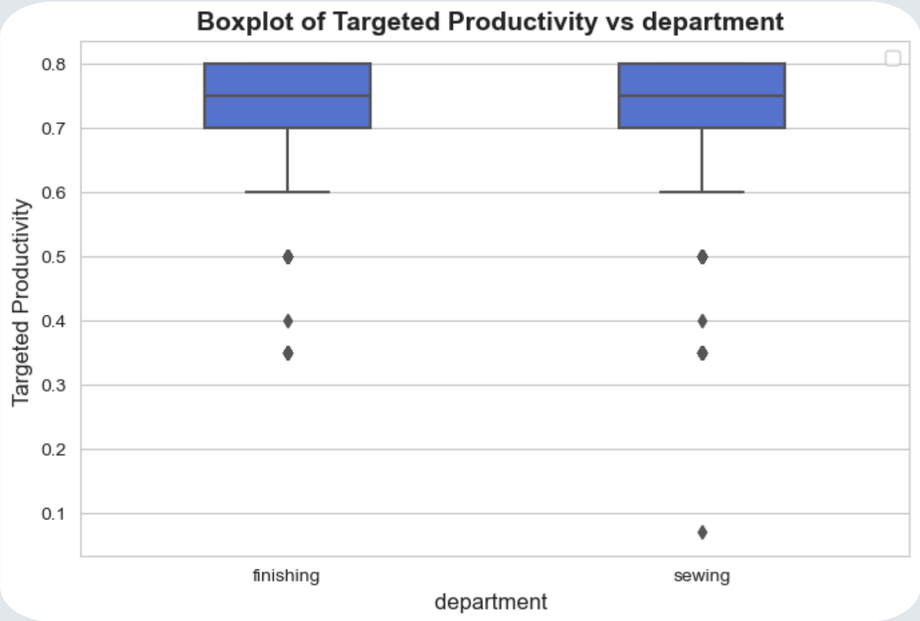
range of incentives:- taka 0-3600
Total incentives :- taka 14040



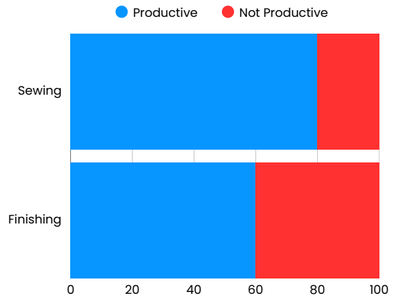
range of incentives:- taka 0-138
Total incentives :- taka 24128

Sewing department low incentives per day but high impact on productivity gain

In finishing department high incentives but less frequent low impact on productivity gain



Productivity goals are same for both departments



20% - **Not Productive** in Sewing

40% - **Not Productive** in Finishing

P > 0.05

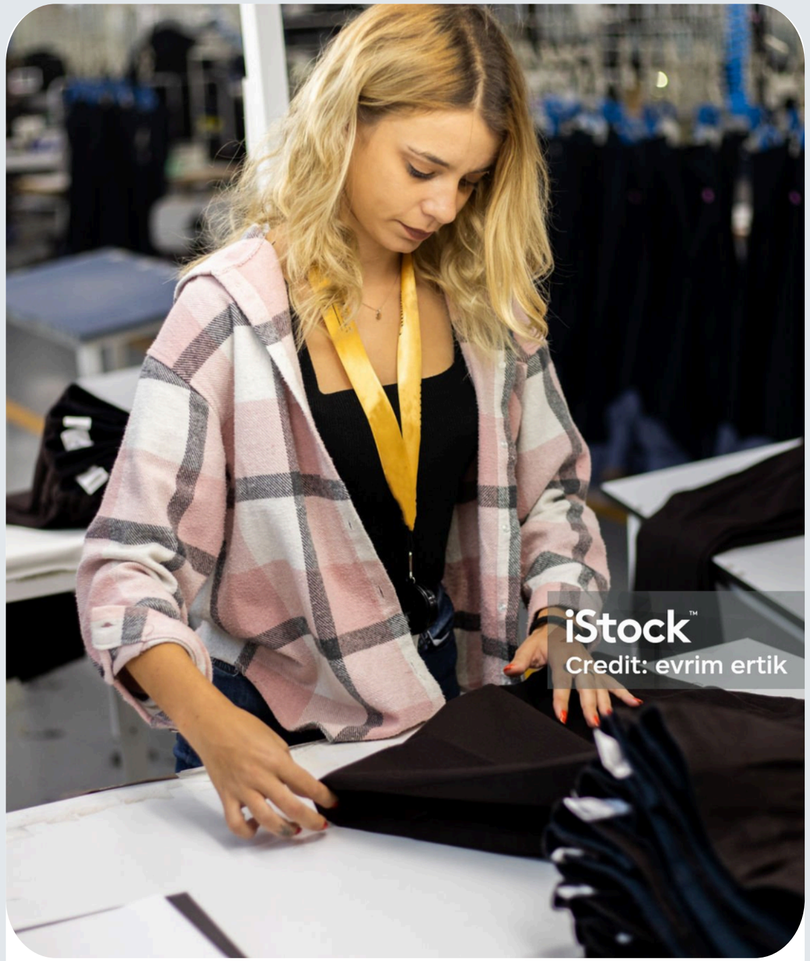
Mann Whitney Test

Productivity goals are same for both departments

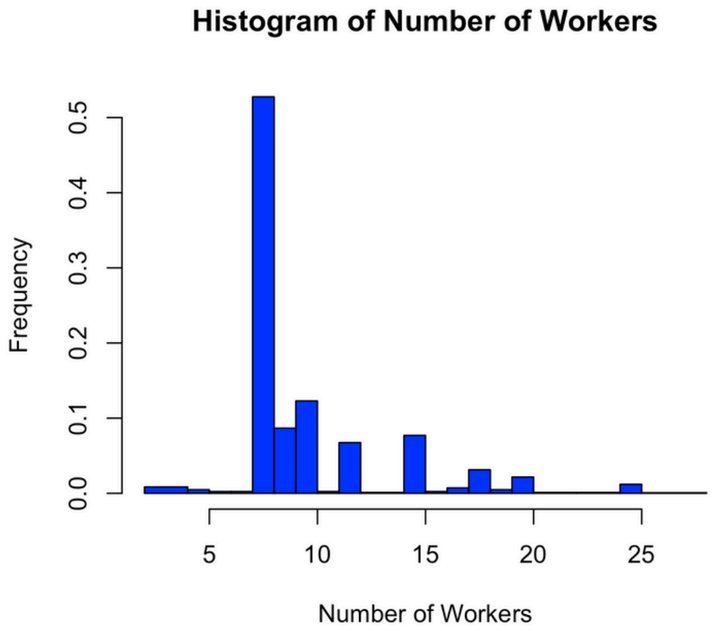
Target Productivity = (Total Target Output per Day × Efficiency) / (Total Working Hours × Maximum Production Rate per Hour)

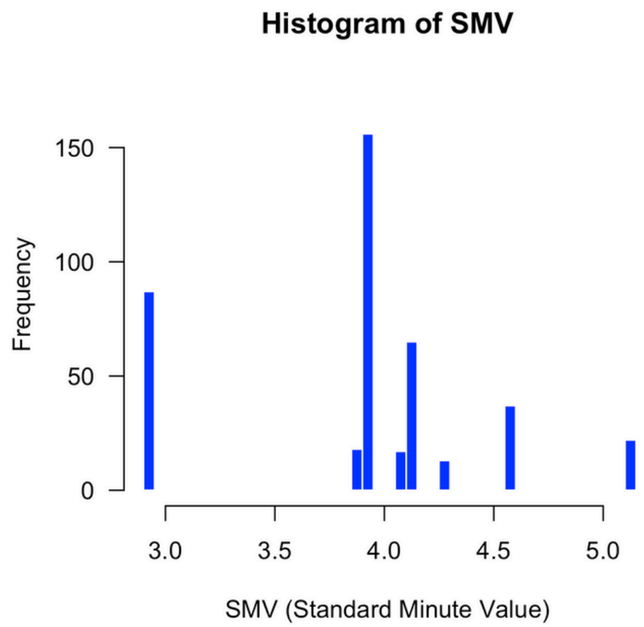
!

focus on calculating target productivities for departments separately



Investigating the number of workers and Standard Minute Value (SMV) for the finishing Department





50% of **number of workers = 8**
Range = 2-28

Smaller SMV tasks are given for the finishing
Range=2.90 5.13

A predictor with low variance doesn't change much, providing limited information about how the dependent variable behaves, making it harder for the model to learn a meaningful relationship

References

01.

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https://fashion2apparel.com/working-procedure-of-sewing-department-in-garment-industry/

02.

Books/Articles

http://repository.wyb.ac.lk/bitstream/handle/1/1722/ASBIRES-2009-97.pdf?sequence=2&isAllowed=y

https://www2.stat.duke.edu/~rcs46/lectures_2017/08-trees/08-tree-regression.pdf

03.

Videos

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