Workers' Feedback Crowdsourcing to Protect Apparel Factories and Brands from Reputational Damage

Introduction

Existing auditing techniques involved a personal visit to the factories that are costly and time consuming. The follow-ups are rather difficult and the information about the associated companies are limited. Despite regular auditing of factories, consecutive incidences took place in multiple apparel factories which completely destroyed the infrastructure of factories and took huge number of human's lives. Such unsafe working conditions provided by the suppliers of apparel brands lead to worker's strikes and factory closures. This resulted in stock-outs, long-lead times, failure to meet customer demands, a huge financial loss and defamation of apparel brands.

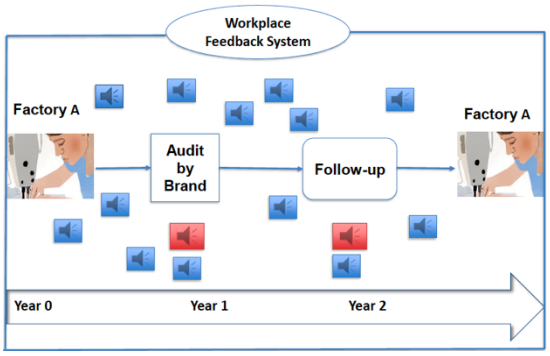

Figure 1: Workers' Feedback Crowdsourcing vs Conventional Auditing Methods

Lack of frequent contacts between supplier and brands, and failure of conventional auditing systems, a new information sharing system is necessary to make sure healthy working environment and keeping good reputation of brands. Workers' feedback crowdsourcing is an innovative approach of auditing the company assets. This is a growing idea to assess the infrastructure and working environment of a company. The concept is based on the "workplace feedback system" (WFS) and it is proposed to address the visible breach unfilled by current factory inspection methods. This project is intended to perform analysis of workers reviews from around 200 branches of a company and to understand the basic issues in each branch as well as in whole company. Supervised machine learning algorithms are implemented to forecast the impact of factory treatment to their workers over the factory outstanding performance.

Problem Description

This project bestows a convincing case for leveraging workers feedback to apprehend apparel factory suppliers working environments in real-time and to reduce the extraneous reputational damage of apparel brands. Based on the factory characteristics, see Table 1, a study is designed to continuously extract feedback of the workers and estimate their concern levels. The better performance of factories requires good feedback of workers about the defined characteristics.

A comprehensive way to forecast factory performance and the work-life balance is set by preparing a questionnaire for the workers to explain their working environment as shown in Table 2. The answers to the questions are based on classification algorithms. Most of the questions are answered as yes/no while the other questions are based on rating. The data set requires concrete data analysis and its visualization by means of advanced machine learning tools. The analysis provides forecasting specific issues that can become the possible reasons for the damage of apparel brands reputation.

Table 1: Factories Characteristics

1. Certificate and rules of operation	2. Abusive Behavior by Factory Managers
3. Supportive Assessment, No aggression	4. Fire Safety at work place
5. Buyer - Supplier Association	6. Child Labor
7. Worker Recommendation	8. Sanitation of Kitchen and Toilets
9. Worker Voluntary Feedback	10. Freedom of Association
11. Long Working Hours	12. Clean Water
13. Wages	14. Forced Overtime

Solution Description

The aim of this study is to find a way to use workers feedback crowdsourcing to protect apparel factories from reputational damage. For this, two objectives are set: (1) find relation between factory characteristics (i.e., workers grievances and factory indicators) and (2) identify prominent grievances of workers based on factory characteristics. These identifications will be used to forecast the factory performance and its long-term impact on the apparel brand.

A proposed solution to the problem is to use factory audit reports that complement the newly proposed data source to gain a more comprehensive picture of the apparel factory working conditions and to protect from negative publicity. The findings also suggest the need for a more comprehensive inspection approach, apart from relying solely on worker crowdsourcing feedback.

The project contains big data set of the review remarks of company workers. Pre-processing of data is necessary before the analysis of worker reviews. Therefore, data preprocessing techniques is applied to make data ready for analysis. Data concatenating, wrangling, cleansing, categorizing into multiple subdivisions are all part of this project.

The study involves all the variables as the features of the model. However, there are certain factors that can be considered as the target variables such as the factory performance, ranking by Audit report of the factory, factory negative / positive feedback can be considered as the target variables. In regards to predictable issue, it has been observed that Forced Overtime is highly correlated to the prospective target variables, particularly supplier output. Therefore, this study has used Forced Overtime as a target variable and see if the concerns about other issues are high then how they are related to the Forced Overtime.

In the data analysis part, two regression techniques are used: Linear Regression and K-neighbors Regression. The scores for predicted training and testing data are calculated to see how much these features are statistically related to target values. Furthermore, the models are cross-validated on different random samples and their scores are calculated. The recursive feature selection technique is used to rank the features and select best three features which can give us good accuracy. These three best features are further analyzed to calculate the cross validation of the predictive model.

Table 2: Worker's Questionnaire

Issue and Concerns	Questions	Possible Responses
FOA	Are you free to join / form new associations / communities?	Yes / No
Clean Water	Do you have access to clean Water?	Yes / No
Worker Recommendation	Do you recommend this factory?	Yes / No
Long Working Hours	Have you worked more than 10 hours continuously in the last month?	Yes / No
Sanitation of Canteens	On a scale of 0 to 4, how would you scale the canteen cleanliness?	0 ,1, 2, 3, 4
Voluntary Feedback	Would you like to provide any other feedback?	Yes / No
Child Labor	Have your witnessed child labor in your factory?	Yes / No
Abuse	Have you experienced any abusive behavior from factory owners in the last month?	Yes / No
Fire Safety	Are the fire exits accessible to you?	Yes / No
Sanitation of Toilets	On a scale of 0 to 4, how would you scale the Toilets cleanliness?	0, 1, 2, 3, 4
Wages	Were your all wages paid on time?	Yes / No
Forced Overtime	Are you forced to work overtime?	Yes / No

Results

The work is performed solely on the Python language. This shows the usefulness of this language and its handling capability to hard-core problems in Data Science. Following packages are part of this project: Pandas for Dataframe tools, Numpy and Math for numerical and mathematical computations, Scikit-Learn for statistical analyses and optimization, MatPlotLib and Seaborn for plotting and visualization purposes. Other packages include os, ordereddict and re.The analytics part of this project consisted of two sections. The first section is about the pre-processing of the collected data and the second section is about the data analysis to address the research objective of this project.

Data Pre-processing

The data set consisted of 256 columns and 22226 rows. Each row represented a unique factory worker. There are 194 factories in total and therefore, on average, there are 50 to 100 workers per factory. By looking manually at the dataset, we collected the most relevant information for this study as shown in Table 2. In this information, 12 questions and their responses are collected along with their respective factory ID, duration and time of feedback collection. Since questions were not asked in the same sequence in each factory, therefore, it required a lot of data cleansing. Table 3 shows the number of missing values found for each question and average number of missing response of each question by the factory workers.

Table 3: Preprocessing of selected features

Factory Worker Survey Features	Before Data Preprocessing	After Data Preprocessing	Missing response Percentage
FOA	22226	7659	**66.4 %**
Clean Water	22226	7908	**64.5 %**
Worker Recommendation	22226	12515	**43.7** %
Long Working Hours	22226	12916	**41.9 %**
Sanitation of Canteens	22226	13109	**41 %**
Voluntary Feedback	22226	1601	**92.7%**
Child Labor	22226	20293	0.09 %
Abuse	22226	20543	0.07 %
Fire Safety	22226	20667	0.07 %
Sanitation of Toilets	22226	21331	0.04 %
Wages	22226	22210	0.00 %
Forced Overtime	22226	7855	**64.7 %**

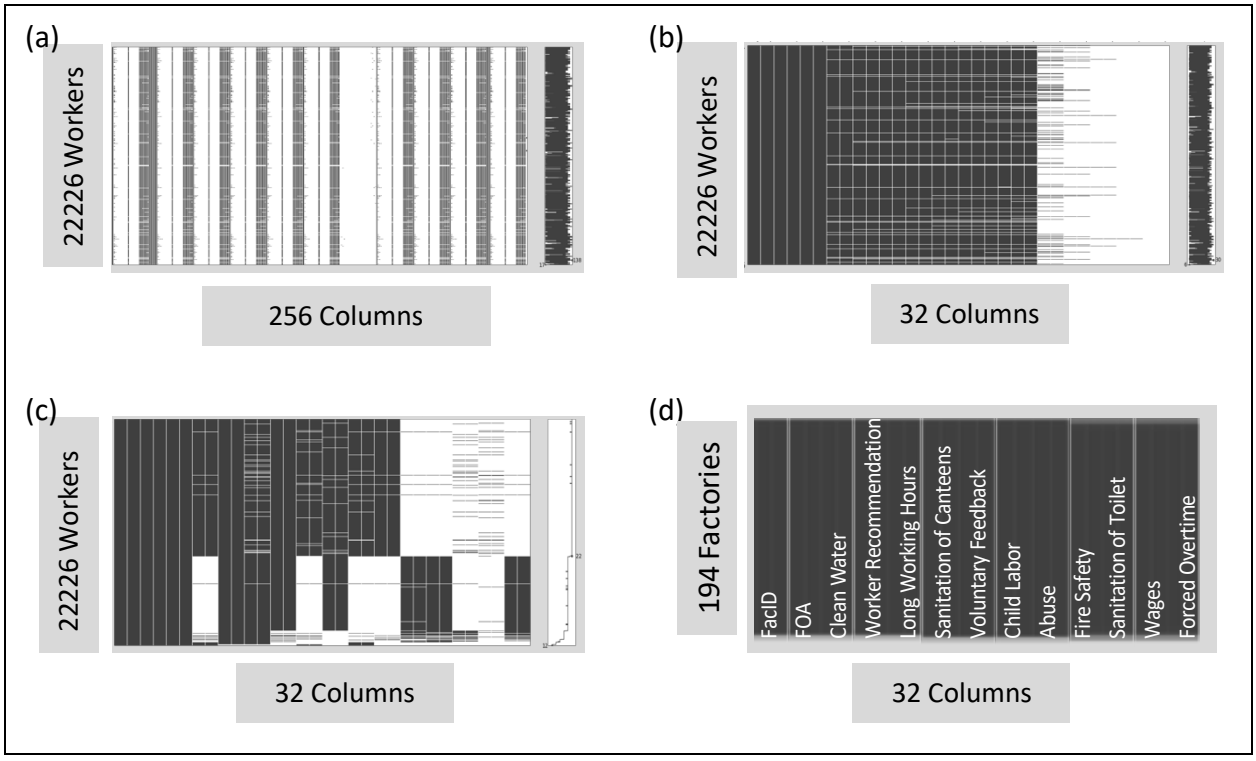

Figure 2: Stages of Data Preprocessing. White color shows missing values and black color shows given values. (a) Original Data Set, (b) Features selection and Missing Data visualization, (c) Data Wrangling and Cleansing, (d) Data cleaned and Columns names as per data contained. Workers Feedback for each factory is normalized for each question separately.

Data Analysis

Issue-based performance of the factories are observed by looking at the overall trend of the workers response in each factory as shown in Figure 3. We observed that almost all the factories have issues with the Sanitation of Toilet and around 60% of the workers have shown their concern. Workers have shown less concern towards providing Voluntary Feedback, Abuse, Child Labor, Long Working Hours and Sanitation of Canteen. The major concerns are Wages, Fire Safety and Clean Water. The feedback about Freedom of Association and Forced Overtime and Sanitation of Toilet is mixed.

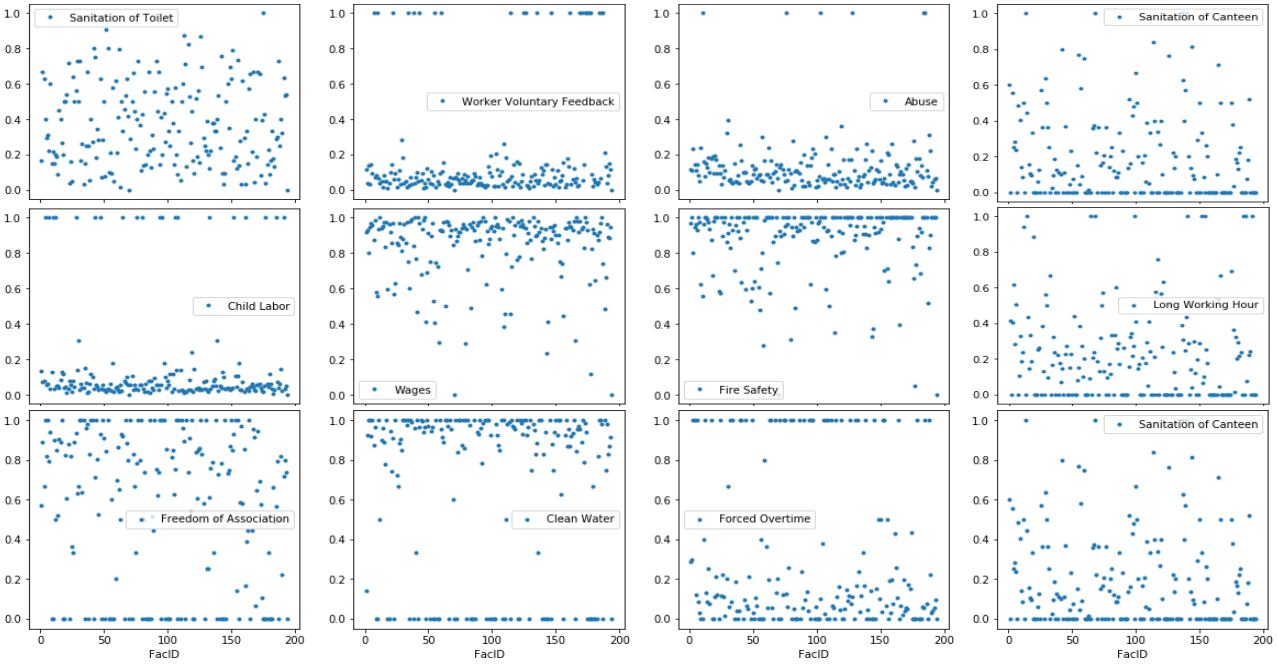

Figure 2: Average performance of each factory on the basis of Workers' feedback.

The predictive modeling techniques are implemented for regression analysis because the target variable is continuous. The dataset is divided into training and testing with the ratio of 0.7:0.3. The linear regression model is implemented over the training data set and it is tested over the testing data set. The model has shown good commitment for both datasets. Further, to measure the predictive performance of the statistical model, cross-validation results show that 4 out of 6 random samples has provided good results for the original data set while the other are completely failed to predict the target variable. The predictive accuracy of the model by R^2 metric is considerably same as the score for testing data set.

Recursive feature elimination technique is used to rank the features. The technique suggests to eliminate those features that are less effective to predict the model. It is observed that the Fire

Safety, Clean Water and Worker Recommendation are the top three features found by using recursive feature elimination technique. Furthermore, the selected features are trained and tested for the linear regression model and found good commitment to each other. The cross validation has also provided better results than the previous model. Five out of six random samples are validated while the last one was poorly predicted.

KNN regression technique is cross-validated and its results are compared with the linear regression model (see Table 4). It is observed that all the six random samples have given good validity to the target variable and performed better than the previous models. The cross predicted score between the predicted values and the testing data values has also shown better result than the linear regression model.

	Linear Regression		**KNN Regression**	
	All Features	**Top 3 Features**	**All Features**	**Top 3 Features**
Predicted vs Test dataset Cross-Prediction	0.445	0.400	0.574	0.568
Cross-Validated Scores with 6 random samples	-0.019	0.255	0.412	0.439
	0.454	0.518	0.542	0.530
	0.611	0.548	0.768	0.463
	0.508	0.517	0.717	0.594
	0.410	0.350	0.422	0.453
	-0.027	-0.040	0.140	0.177

Conclusion

The results selected best three features as Fire Safety, Clean Water and Worker Recommendation against the Forced Overtime as target variable. The results show that workers working late at the factory have higher concerns about Fire Safety, Clean Water. And they are not willing to recommend factory to other people. Both models have shown good commitment however KNN regression have shown better results. In future work, Factory output and Negative/Positive Feedbacks could also be considered as the target variable.