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Approach for Data-Driven

Work Skills of Saudi Aramco's

Highlights

Enhancing Demand Forecasting

Concept for Promoting Business

Discovering Thoughts, Inventing Future

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Enhancing Demand Forecasting in Retail Supply Chains: A Machine Learning Regression Approach

By Tewogbade Shakir & Akinlose Modupe

Abstract- This investigation discusses the importance of supply chain management and the role of demand forecasting in the business circle and presents a review of literature on demand forecasting techniques, emphasizing the shift from traditional methods to more sophisticated statistical and machine learning approaches.

The study aims to contribute to existing knowledge on demand forecasting by utilizing machine learning regressors to predict orders in a Brazilian logistics company. It showed the use of the PyCaret Python library to develop robust regression models and validate key contributing features through feature importance plots. The performance of eighteen models, including Ridge, LASSO, XGBoost, Bayesian Ridge, Linear Regression, Gradient Boosting, KNN, Random Forest, among others, is evaluated using the Mean Absolute Error (MAE) metric.

In order to make accurate predictions, feature important plot was used to validate features that have a strong positive correlation with the target variable, such as non-urgent orders, urgent orders, and orders from the traffic controller sector. The performance of different regression models, including Linear Regression, Lasso Regression, Ridge Regression, Lasso Least Angle Regression, Bayesian Ridge, and Elastic Net were discussed.

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Enhancing Demand Forecasting in Retail Supply Chains: A Machine Learning Regression Approach

Tewogbade Shakir [α] & Akinlose Modupe [σ]

Abstract- This investigation discusses the importance of supply chain management and the role of demand forecasting in the business circle and presents a review of literature on demand forecasting techniques, emphasizing the shift from traditional methods to more sophisticated statistical and machine learning approaches.

The study aims to contribute to existing knowledge on demand forecasting by utilizing machine learning regressors to predict orders in a Brazilian logistics company. It showed theuse of the PyCaret Python library to develop robust regression models and validate key contributing features through feature importance plots. The performance of eighteen models, including Ridge, LASSO, XGBoost, Bayesian Ridge, Linear Regression, Gradient Boosting, KNN, Random Forest, among others, is evaluated using the Mean Absolute Error (MAE) metric.

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I. Introduction

According to Chopra and Meindil 2011, supply chain is a system that consists of a manufacturers, suppliers, transporters, distributors and retailers; where they all share information and goods and services are delivered among them to meet up with the demand ofconsumers. Considering the set of entities involved, supply chain is considered as a major aspect in the business circle. It is a whole cycle of procedures and end-to-end flow of materials, information and funds starting from the product design stage to fulfilment. As noted by Casson 2013, economics factors are the key factor in supply chain as it shows greater impact on size and shape. Beyond economic factors, Ketchen and Giunipero 2004 highlighted the effect of strategic choices on supply chain set up, coordination and operation.To deliver best and optimal solution, supply chain activities must be strategically laid out, coordinated and handled. Proper coordination will emanate from balancing the demand and supply ends. Various variables such as weather, market trends, and season, consumer behaviour exist between the two ends and thus coordinate planning must be fashioned out. The volatility in these variables prompt for demand forecasting. As mentioned by Hope and Fraser 2003, demand forecasting is one of the prerequisites for strategical planning in supply chain management. Many techniques and methods have been used to investigate contributing variables and forecasting of orders based on historical data. In this study machine learning regressors will be used to make order predictions using dataset acquired on the field for 60 days in a Brazilian logistics company. Machine learning is a sophisticated methods posit by advancement in computing technology where historical data are trained to build models which are subsequently used to make predictions. It exists as classification or regression means. For regression, predictions are made for continuous variables like demand in supply chain. According to Al-Jarrah et al 2015, machine learning is perfectly efficient in the analysis of voluminous data that exist in demand forecasting study. To effect more accurate demand prediction, robust regressors models will be developed using Python Library PyCaretwhile key contributing features are validated through feature importance plot. The various machine learning models (Ridge, LASSO, XGBoost, Bayesian Ridge, Linear Regression, Gradient Boosting, KNN, Random Forest and others) will run concurrently and their prediction performance measured with Mean Absolute Error (MAE): the mean absolute differences between predicted values and actual demand values. The lesser the MAE, the better the model predictions.

II. Literature Review

One of the important steps in supply chain planning is demand forecasting. By standard forecasting includes element of uncertainty as it is often hard to predict perfectly in a consistent manner. Thus, because of volatility involved in demand and uncertainty in forecasting, many research have been carried out over the years to improve decision making in supply chain. Carbonneau, Laframboise and Vahidor 2008 classified naïve method, average method, moving average and trend as traditional methods and viewed them as solution approach based on linear demand idealization. Due to emerging complexity in demand situations in supply chain field, non-linear techniques were proposed in their paper to handle the complexity. They made used of machine learning techniques-neural

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network, recurrent neural networks and SVM to predict future demand and confirmed better outcomes compared to the traditional methods. MAE was used to compute error analysis for their model predictors in order to evaluate which among them best fits the study dataset. The results revealed that recurrent neural networks and SVM yielded most accurate predictions. A similar investigation by Wang 2012 using large paper enterprise dataset showed that support vector regression produced excellent performance. A more comprehensive study is seen in the work of Rivera-Castro et al 2019 where their experiments was performed using thirteen techniques that cut across times series and machine learning (Adaboost, ARIMAX, ARIMA, Bayesian Structure Time Series (BSTS), Bayesian Structural Time Series with a Bayesian Classifier (BSTS Classifier), Ensemble of Gradient Boosting, Ridge Regression, Kernel Regression, LASSO, Neural Network, Poisson Regression, Random Forest and Support Vector Regression). Symmetric Mean Absolute Percent Error (SMAPE) was used to evaluatethe model's performance and Adaboost yielded best model with SMAPE of 0.17 followed byensemble of Random Forest 0.18. Review of literatures has shown paradigm shift from traditional approach (Historical Analogy, Scenario Planning, Moving Averages, Exponential Smoothing and others) of predicting demand to more sophisticated tools of statistical methods and machine learning. In order to improve existing knowledge on demand forecasting, this study will follow the path of Rivera-Castro et al 2019 by making using of advanced Python Library that yield prediction across many regressions' algorithms simultaneously. Pycaret is an open-source machine learning library and it is low-code. It is distinct in its ability to train and evaluate multiple models with few line of codes. Another improvement is mode of error analysis which is run through MAE, MSE, RMSE, RMSLE and MAPE for each of the models. Thus, there is opportunity for utilization of many metricsto gauge prediction performances.

III. Methodology

a) *Data Pre-processing*

The dataset utilized for this investigation is from UCI repository Daily Demand Forecasting Orders - UCI Machine Learning Repository. It was acquired on the field by a Brazilian Logistic company for a period of sixty days. The attribute of the dataset was shown using Pandas library at pre-processing stage.

```
import pandas as pd
```

```
df = pd.read_excel('supply chain.xlsx')
```

```
df.head()
```

	Week of the month (first week, second, third, fourth or fifth week	Day of the week (Monday to Friday)	Non-urgent order	Urgent order	Order type A	Order type B	Order type C	Fiscal sector orders	Orders from the traffic controller sector	Banking orders (1)	Banking orders (2)	Banking orders (3)	Target (Total orders)
0	1	4	316.307	223.270	61.543	175.586	302.448	0.000	65556	44914	188411	14793	539.577
1	1	5	128.633	96.042	38.058	56.037	130.580	0.000	40419	21399	89461	7679	224.675
2	1	6	43.651	84.375	21.826	25.125	82.461	1.386	11992	3452	21305	14947	129.412
3	2	2	171.297	127.667	41.542	113.294	162.284	18.156	49971	33703	69054	18423	317.120
4	2	3	90.532	113.526	37.679	56.618	116.220	6.459	48534	19646	16411	20257	210.517

Figure 1: Importing Data using Pandas

The dataset was validated for occurrence of missing values in the coding environment.

```
# Checking for missing values
df.isnull().sum()
```

```
Week of the month (first week, second, third, fourth or fifth week    0
Day of the week (Monday to Friday)                                    0
Non-urgent order                                                      0
Urgent order                                                          0
Order type A                                                          0
Order type B                                                          0
Order type C                                                          0
Fiscal sector orders                                                  0
Orders from the traffic controller sector                             0
Banking orders (1)                                                    0
Banking orders (2)                                                    0
Banking orders (3)                                                    0
Target (Total orders)                                                 0
dtype: int64
```

Figure 2: Checking for Missing Values

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Summary statistics of the dataset was evaluated to understand the distribution of thevariables. This provides insights relevant to our analysis.

```
# Summary statistics
df.describe()
```

	Week of the month (first week, second, third, fourth or fifth week	Day of the week (Monday to Friday)	Non-urgent order	Urgent order	Order type A	Order type B	Order type C	Fiscal sector orders	Orders from the traffic controller sector	Banking orders (1)	Banking orders (2)	Banking orders (3)	
count	60.000000	60.000000	60.000000	60.000000	60.000000	60.000000	60.000000	60.000000	60.000000	60.000000	60.000000	60.000000	6
mean	3.016667	4.033333	172.554933	118.920850	52.112217	109.229850	139.531250	77.396133	44504.350000	46640.833333	79401.483333	23114.633333	30
std	1.282102	1.401775	69.505788	27.170929	18.829911	50.741388	41.442932	186.502470	12197.905134	45220.736293	40504.420041	13148.039829	8
min	1.000000	2.000000	43.651000	77.371000	21.826000	25.125000	74.372000	0.000000	11992.000000	3452.000000	16411.000000	7679.000000	12
25%	2.000000	3.000000	125.348000	100.888000	39.456250	74.916250	113.632250	1.243250	34994.250000	20130.000000	50680.500000	12609.750000	23
50%	3.000000	4.000000	151.062500	113.114500	47.166500	99.482000	127.990000	7.831500	44312.000000	32527.500000	67181.000000	18011.500000	28
75%	4.000000	5.000000	194.606500	132.108250	58.463750	132.171000	160.107500	20.360750	52111.750000	45118.750000	94787.750000	31047.750000	33
max	5.000000	6.000000	435.304000	223.270000	118.178000	267.342000	302.448000	865.000000	71772.000000	210508.000000	188411.000000	73839.000000	61

Figure 3: Summary Statistics for Dataset Attributes

The average number of non-urgent orders is around 172.55, with a standard deviation of 69.50. The minimum number of non-urgent orders is 43.65, and the maximum is 435.30. The average number of urgent orders is around 118.92, with a standard deviation of 27.17. The minimum number of urgent orders is 77.37, and the maximum is 223.27. The average number of orders from the fiscal sector is around 77.39, with a standard deviation of 186.50. The minimum number of orders from the fiscal sector is 0, and the maximum is 865. The average number of orders from the traffic controller sector is around 44504.3, with a standard deviation of 12197.9. The minimum number of orders from the traffic controller sector is 11992, and the maximum is 71772.

b) Exploratory Analysis

To visualize the correlation between the dataset variables correlation matrix was employed. This will aid understanding of the relationships between different features and the target variable. The heatmap shows the correlation between different variables in the dataset. The colour scale represents the correlation coefficient, with dark blue indicating a strong negative correlation, light blue to light red indicating little to no correlation, and dark red indicating a strong positive correlation.

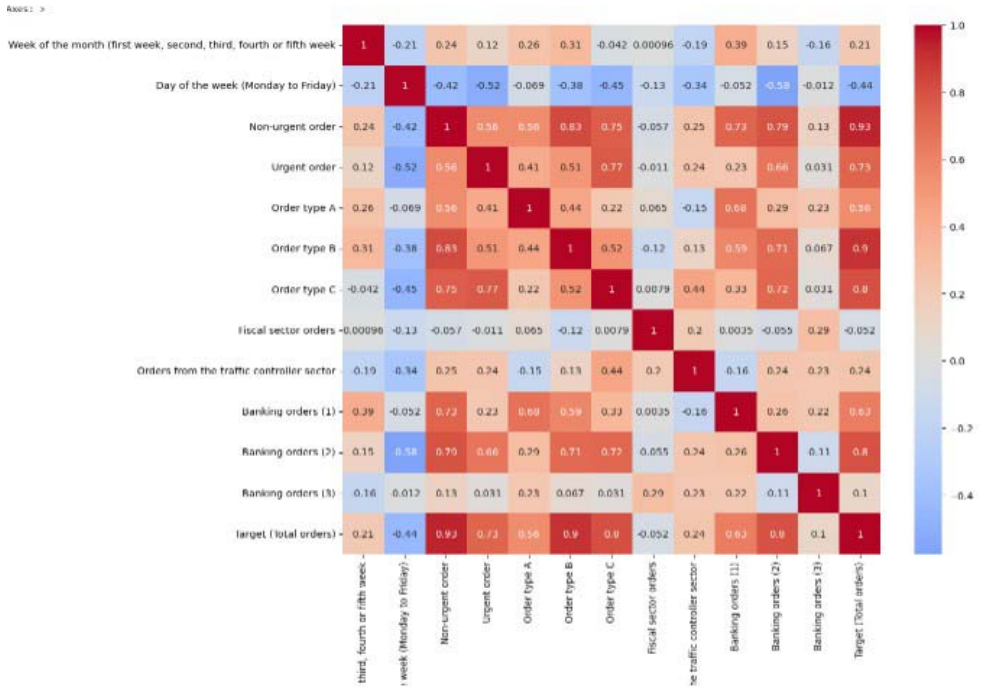

Figure 4: Heatmap to Show Correlation among Features

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From the heatmap, we can see that non-urgent order, urgent order, order type A, order type B, order type C, and orders from the traffic controller sector have a strong positive correlation with Target (Total orders). This suggests that these variables will be good predictors for the total orders.

c) Machine Learning Predictions

i. *Linear Regression*

We started off from modelling weekly order volume with linear regression. Then make use of other regression models (Decision Tree and Random Forest) and compare their performances. The whole dataset is split into a training set and a test set in ratio 80:20.

```
from sklearn.model_selection import train_test_split

# Defining the features and target variable
X = df.drop('Target (Total orders)', axis=1)
y = df['Target (Total orders)']

# Splitting the data into training and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

Figure 5: Splitting Dataset to Training and Test Sets

Linear regression remits a linear relationship between the features and the target variable. The linear regressor is trained with training set while its performance is evaluated using the test set.

```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score

# Creating a Linear Regression model
lr = LinearRegression()

# Training the model
lr.fit(X_train, y_train)

# Making predictions on the test data
y_pred_lr = lr.predict(X_test)

# Evaluating the model
mse_lr = mean_squared_error(y_test, y_pred_lr)
r2_lr = r2_score(y_test, y_pred_lr)

mse_lr, r2_lr
```

```
(4.668373655643919e-24, 1.0)
```

Figure 6: Coding for Linear Regression

The linear regression model has a Mean Squared Error (MSE) of approximately 4.24e-24 and an R-squared (R^2) score of 1.0 on the test data. The R^2 score is a statistical measure that represents the proportion of the variance for a dependent variable that's explained by an independent variable(s) in a regression model. An R^2 score of 1.0 indicates that the model explains all the variability of the response data around its mean, which is a perfect score. However, a perfect score is suspicious and could be a sign of overfitting, where the model has learned the training data too well and may not perform well on new, novel data.

ii. *Decision Trees Regressor*

Decision trees are a type of model used for both lassification and regression. Trees responds to sequential questions which send us down a specific route of the tree. The model gets to produce decision for each feature, where each decision leads to a new question (decision) until a prediction is executed.

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```
from sklearn.tree import DecisionTreeRegressor

# Creating a Decision Tree Regressor model
dt = DecisionTreeRegressor(random_state=42)

# Training the model
dt.fit(X_train, y_train)

# Making predictions on the test data
y_pred_dt = dt.predict(X_test)

# Evaluating the model
mse_dt = mean_squared_error(y_test, y_pred_dt)
r2_dt = r2_score(y_test, y_pred_dt)

mse_dt, r2_dt
```

```
(5332.670754499999, 0.47899695889204263)
```

Figure 7: Coding for Decision Tree Regression

The Decision Tree Regressor model has a Mean Squared Error (MSE) of approximately 5332.67 and an R-squared (R^2) score of 0.48 on the test data. This model's performance is significantly lower than the linear regression model. The R^2 score of 0.48 indicates that themodel explains about 48% of the variability in the target variable.

iii. *Random Forest Regressor*

Random Forest is a type of ensemble learning method, where a group of weak models come together to form a strong model. In Random Forest, we grow multiple trees as opposed to a single tree. To classify a new object based on attributes, each tree gives a classification. The forest chooses the classification having the most votes (over all the trees in the forest) and incase of regression, it takes the average of outputs by different trees.

```
from sklearn.ensemble import RandomForestRegressor

# Creating a Random Forest Regressor model
rf = RandomForestRegressor(random_state=42)

# Training the model
rf.fit(X_train, y_train)

# Making predictions on the test data
y_pred_rf = rf.predict(X_test)

# Evaluating the model
mse_rf = mean_squared_error(y_test, y_pred_rf)
r2_rf = r2_score(y_test, y_pred_rf)

mse_rf, r2_rf
```

```
(3301.721138390172, 0.677421158517971)
```

Figure 8: Coding for Random Forest Regression

The Random Forest Regressor model has a Mean Squared Error (MSE) of approximately 3301.72 and an R-squared (R^2) score of 0.68 on the test data. This model's performance is also lower than the linear regression model but greater than that of decision tree. The R^2 score of 0.68 indicates that the model explains about 68% of the variability in the target variable.

d) Combined Regressors by PyCaret

PyCaret is a very robust Python library that will be used to compare different regression models and find the best one for our dataset. Firstly, regression module is set up in PyCaretwith our dataset. Then, the *compare_models* function is used to compare different models. This function trains all models in the model

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library using cross-validation and evaluates performance metrics for regression, such as MAE, MSE, RMSE, R2, RMSLE, and MAPE. Another merit from this approach is that PyCaret library takes care of all the pre-processing steps such as missing value imputation, encoding categorical variables, feature scaling and normalization. This is shown as TRUE in figure 9 below.

```
from pycaret.regression import *

# Initialize setup
s = setup(df, target = 'Target (Total orders)', session_id = 123)
```

	Description	Value
0	Session id	123
1	Target	Target (Total orders)
2	Target type	Regression
3	Original data shape	(60, 13)
4	Transformed data shape	(60, 13)
5	Transformed train set shape	(42, 13)
6	Transformed test set shape	(18, 13)
7	Numeric features	12
8	Preprocess	True
9	Imputation type	simple
10	Numeric imputation	mean
11	Categorical imputation	mode
12	Fold Generator	KFold
13	Fold Number	10
14	CPU Jobs	-1
15	Use GPU	False
16	Log Experiment	False
17	Experiment Name	reg-default-name
18	USI	ebc3

Figure 9: Initializing PyCaret Regression

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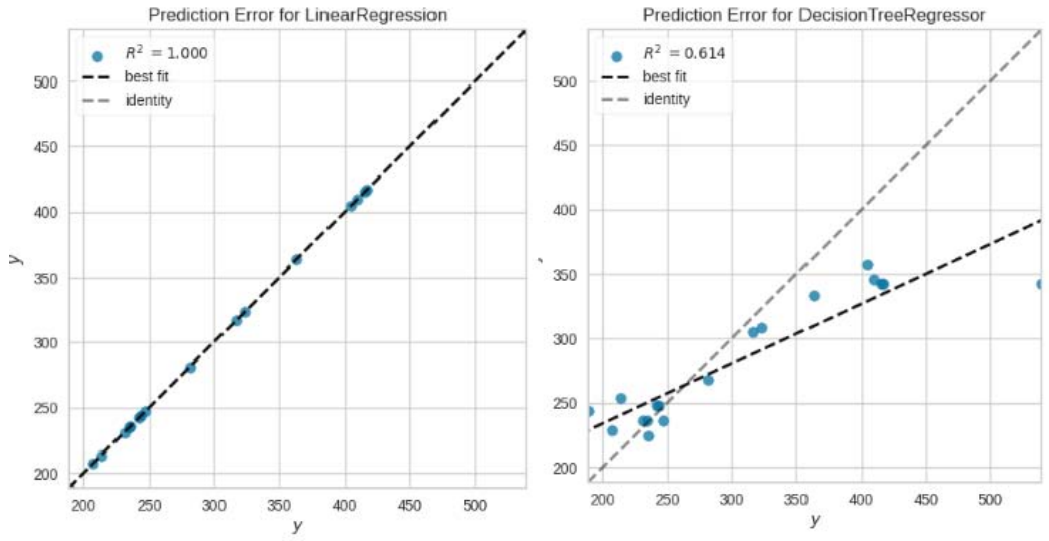
```
# Comparing all models
best_model = compare_models()
```

	Model	MAE	MSE	RMSE	R2	RMSLE	MAPE	TT (Sec)
lr	Linear Regression	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.2410
lasso	Lasso Regression	0.1612	0.0599	0.2003	1.0000	0.0006	0.0005	0.0320
ridge	Ridge Regression	0.0101	0.0005	0.0140	1.0000	0.0000	0.0000	0.0300
llar	Lasso Least Angle Regression	0.1613	0.0589	0.1998	1.0000	0.0006	0.0005	0.0310
br	Bayesian Ridge	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0320
en	Elastic Net	0.2196	0.2108	0.3036	0.9998	0.0009	0.0007	0.0320
huber	Huber Regressor	13.1549	601.3146	18.2020	0.5207	0.0559	0.0409	0.0490
et	Extra Trees Regressor	18.9690	891.9745	24.7828	0.3170	0.0823	0.0657	0.1810
gbr	Gradient Boosting Regressor	19.8730	842.0865	25.1282	0.1901	0.0837	0.0684	0.0820
xgboost	Extreme Gradient Boosting	24.2394	1507.4219	32.4543	-0.0233	0.1033	0.0783	0.0520
rf	Random Forest Regressor	26.4847	1590.3080	34.5563	-0.3531	0.1075	0.0875	0.3490
ada	AdaBoost Regressor	27.1256	1507.4559	34.1499	-0.7393	0.1136	0.0940	0.0830
omp	Orthogonal Matching Pursuit	52.3762	4421.5898	59.9154	-1.5530	0.1948	0.1762	0.0300
dt	Decision Tree Regressor	36.5792	2991.5417	46.9773	-1.5823	0.1623	0.1238	0.0340
lar	Least Angle Regression	10.1883	472.8763	12.8457	-2.3624	0.0447	0.0380	0.0330
knn	K Neighbors Regressor	43.2565	4332.4947	58.0248	-2.4464	0.1783	0.1385	0.0310
lightgbm	Light Gradient Boosting Machine	61.1941	8041.0637	78.2081	-6.5747	0.2508	0.2113	0.0910
dummy	Dummy Regressor	61.1941	8041.0636	78.2081	-6.5747	0.2508	0.2113	0.0350
par	Passive Aggressive Regressor	125.4990	34680.1443	143.2859	-94.0216	0.3445	0.3983	0.0310

Figure 10: Comparing Models from Eighteen Regressors

The best model according to PyCaret comparison is the linear regression model. This is consistent with our earlier analysis where the linear regression model had an R^2 score of 1.0. However, as mentioned earlier, a perfect score is suspicious and could be a sign of overfitting, where the model has learned the training data too well and may not perform wellon new, unseen data. It is important to note that PyCaret *compare_models* function uses cross-validation to evaluate the models, which provides a more robust assessment of the model's performance. Therefore, the linear regression model's perfect score in this case is less likely to be due to overfitting. The linear regression model seems to be the best model for predicting the weekly order volume based on the given features.



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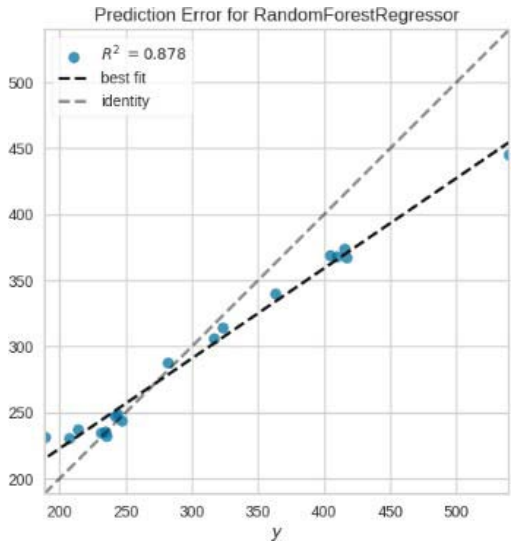

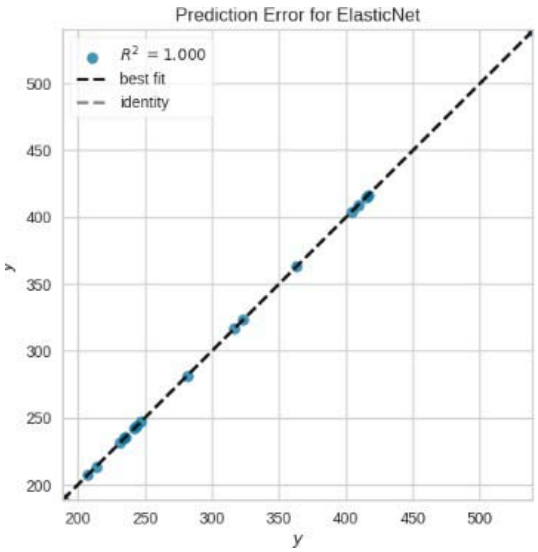

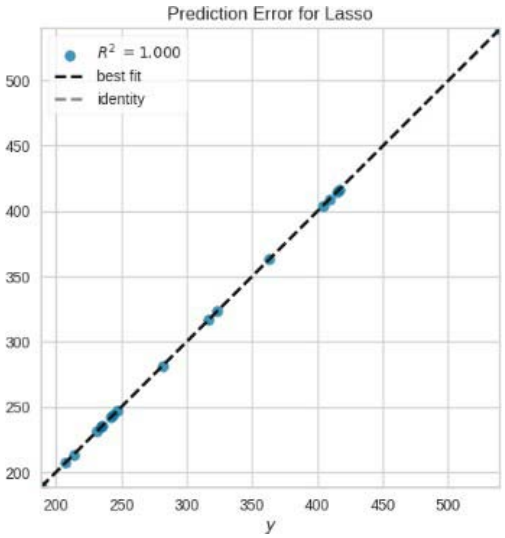

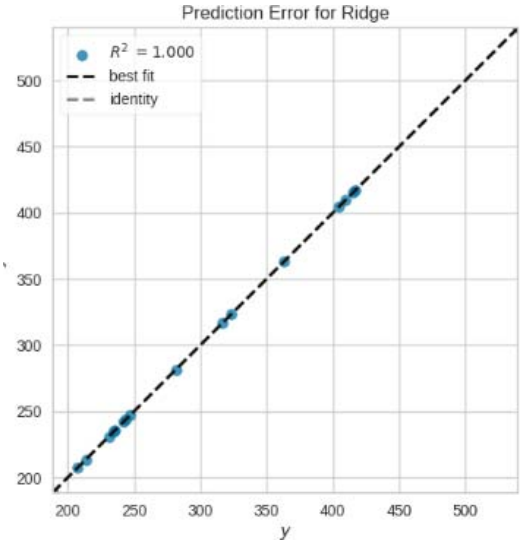

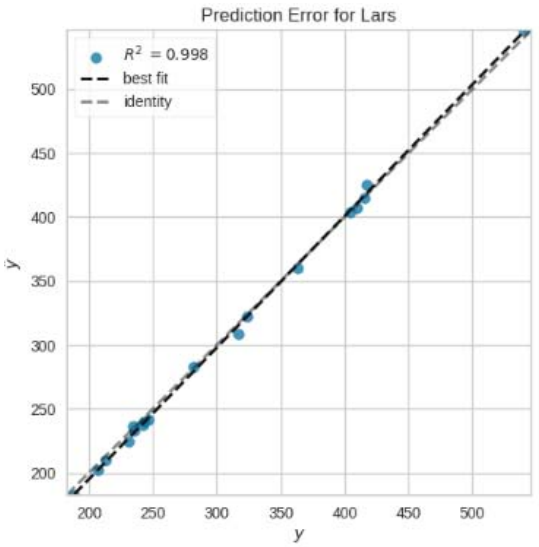

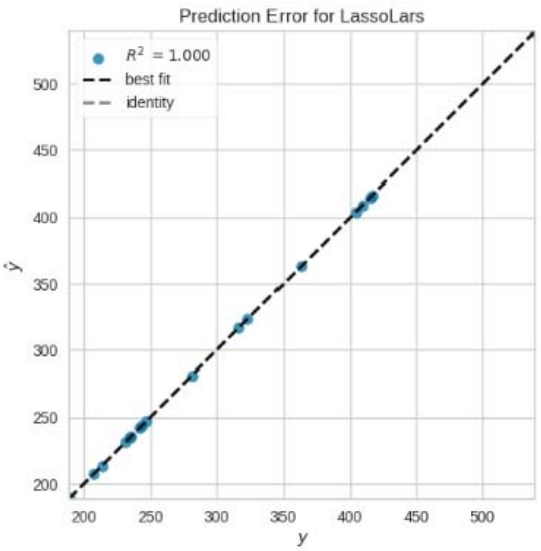

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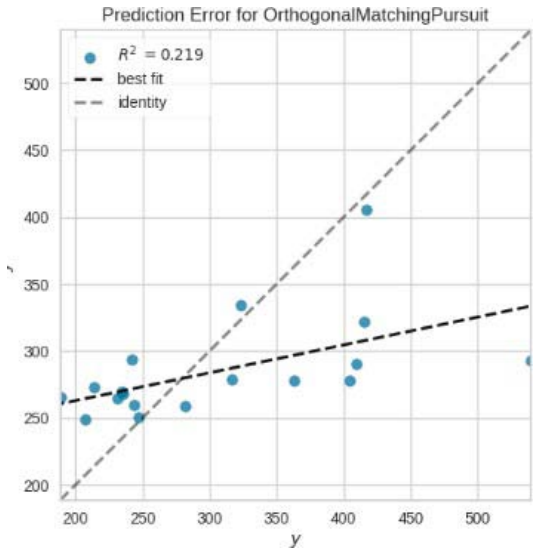

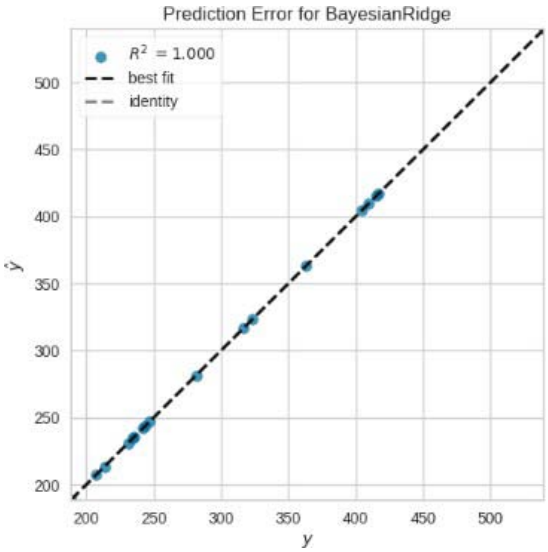

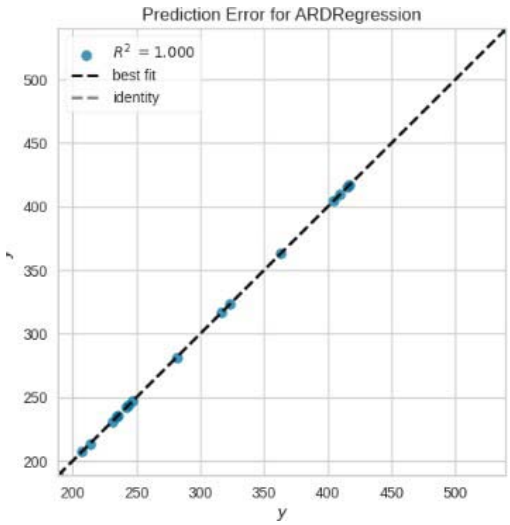

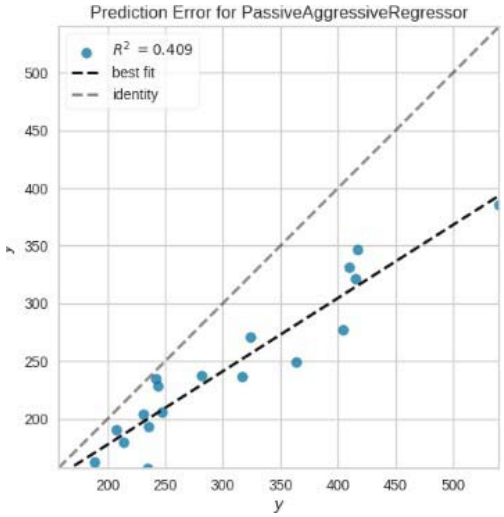

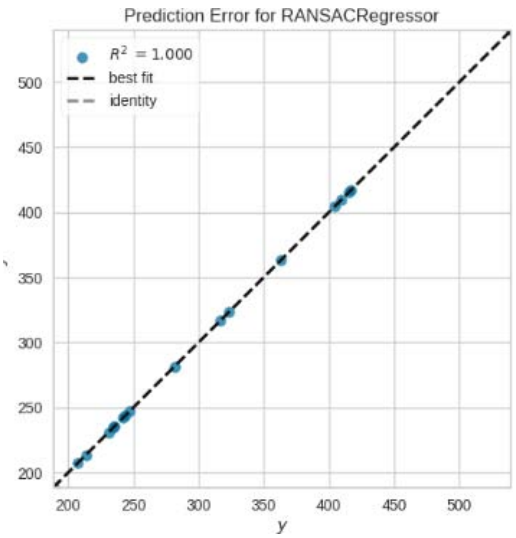

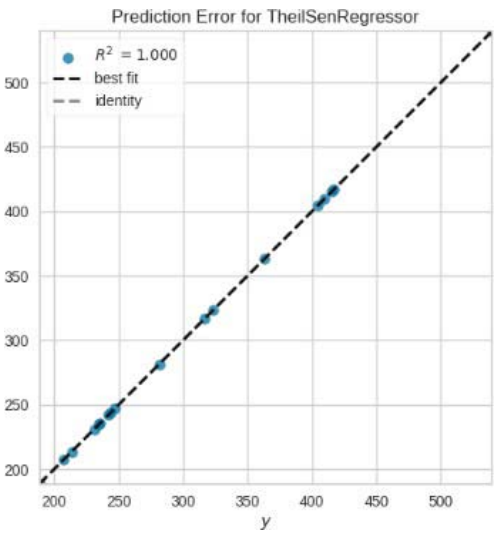

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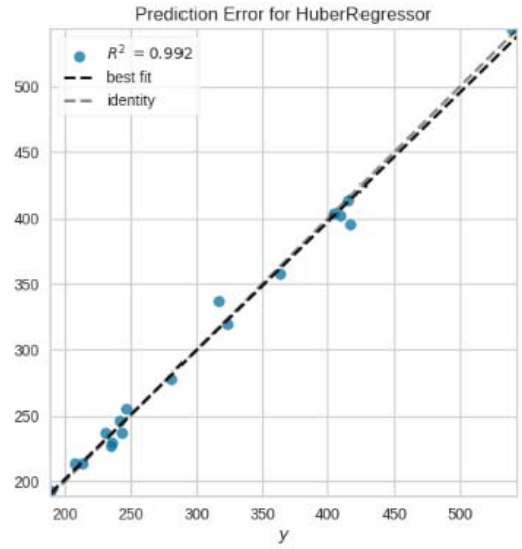

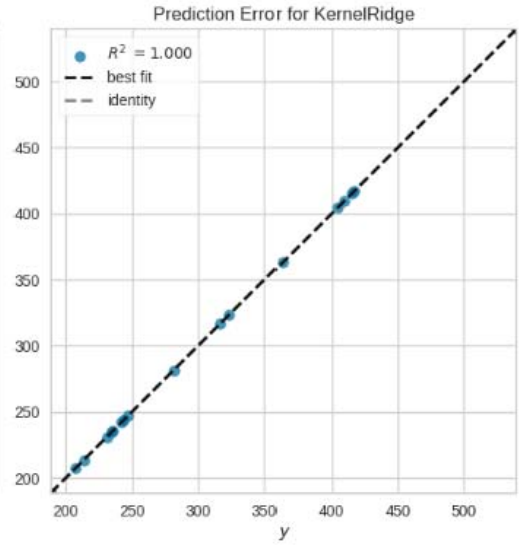

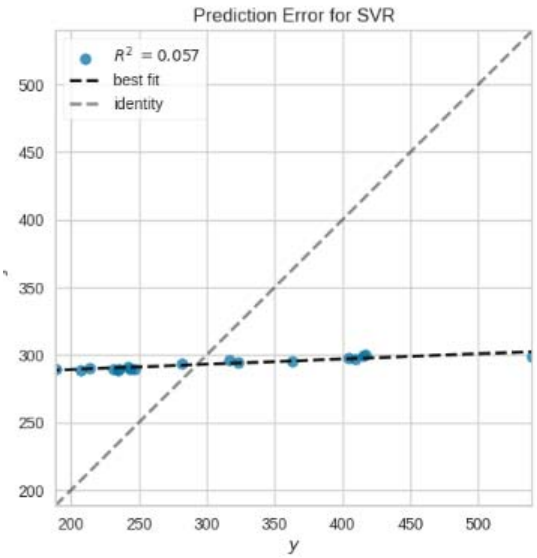

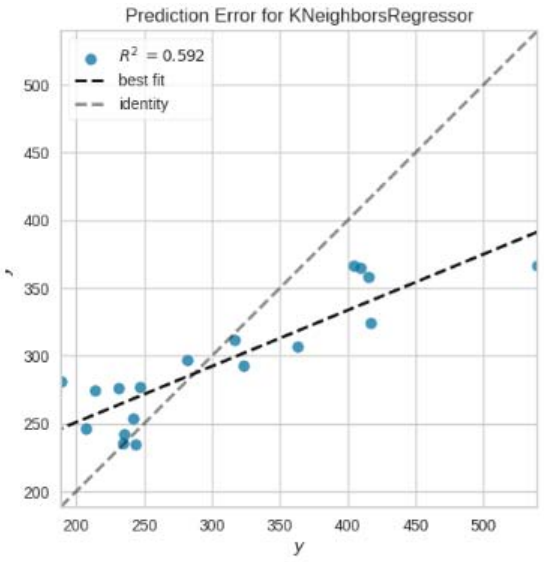

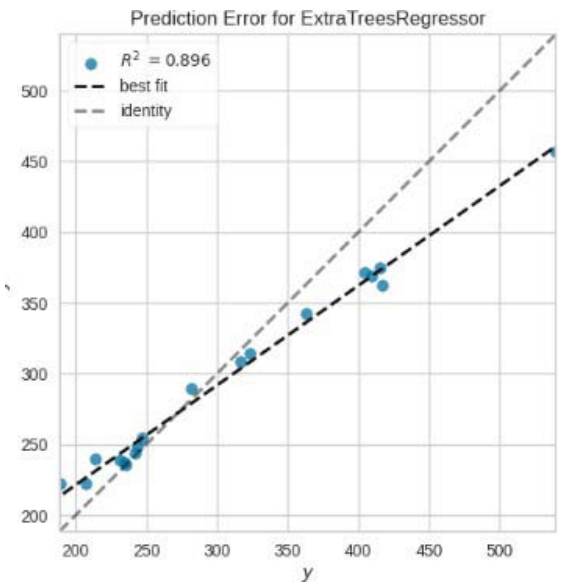

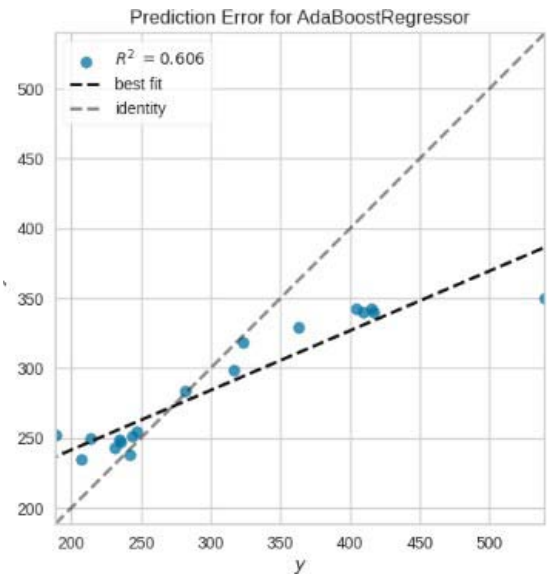

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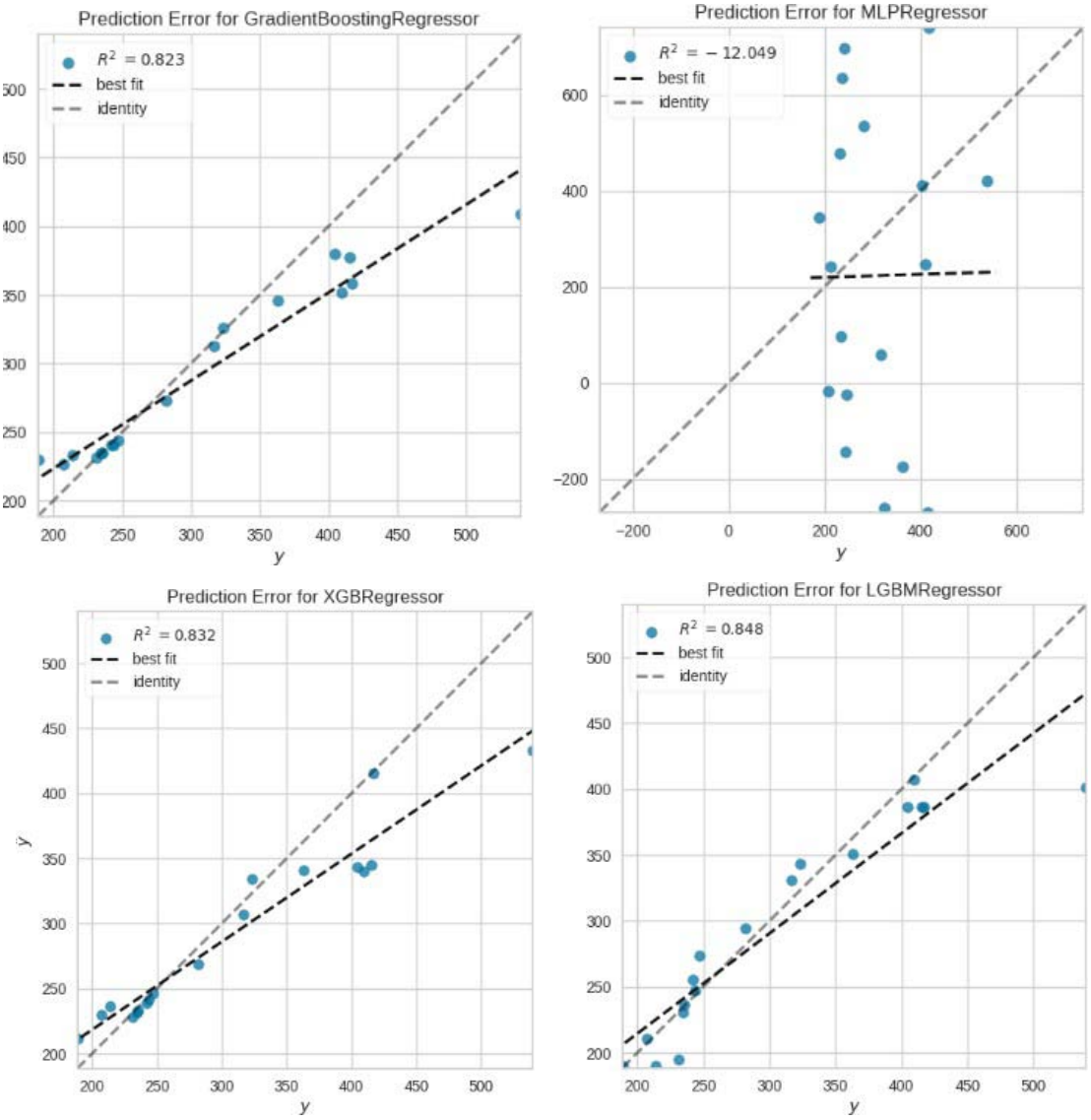

Figure 11: Prediction Plots

The feature importance plot shows the importance of each feature in predicting the target variable in the linear regression model.

```
# Print the best model
print(best_model)

LinearRegression(n_jobs=-1)

# Plotting feature importance
plot_model(best_model, plot = 'feature')
```

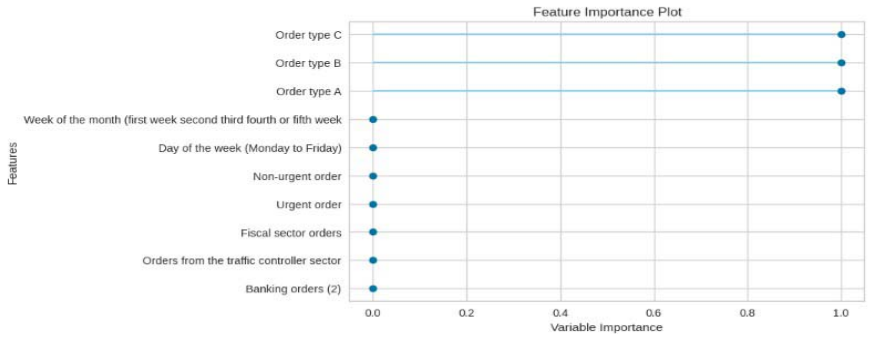

Figure 12: Feature Importance Plot

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From the plot, we can see that the most important features for predicting the total orders are:

1. Orders from the traffic controller sector (the most important feature, with the highest importance score).
2. Order Type C: This is the second most important feature.
3. Non-Urgent Order: This is the third most important feature.
4. Order Type B: This is the fourth most important feature.
5. Urgent Order: This is the fifth most important feature.

The other features have relatively lower importance scores and they can be classified as less relevant in the study analysis.

IV. Results and Discussion

From figure 10, we picked the first six models with smaller MAE and better predictions for discussion. The rest of the models from Huber Regressor to Passive Aggressive Regressor have high value of MAE and their predictions are less accurate.

a) Linear Regression (LR)

Table 1: Performance Parameters for Linear Regression Model

Model Performance Parameters	Value
MAE	0.0000
MSE	0.0000
RMSE	0.0000
R^2	1.0000
RMSLE	0.0000
MAPE	0.0000
TT (Training Time)	0.5810 seconds

The linear regression model achieves perfect performance with MAE, MSE, RMSE, and RMSLE values of 0.0000, indicating that it perfectly predicts the target variable without any error. The R^2 value of 1.0000 suggests that the model explains all the variance in the data.

Additionally, the MAPE value of 0.0000 indicates that the average percentage error is zero. The training time (TT) is 0.5810 seconds, which is the time taken to train the model.

b) Lasso Regression (LASSO)

Table 2: Performance Parameters for LASSO Model

Model Performance Parameters	Value
MAE	0.1612
MSE	0.0599
RMSE	0.2003
R^2	1.0000
RMSLE	0.0006
MAPE	0.0005
TT (Training Time)	0.0890 seconds

The Lasso regression model achieves good performance with a relatively low MAE of 0.1612. The MSE and RMSE values indicate the average squared difference and square root of the average squared difference between predictions and actual values, respectively. The R^2value of 1.0000 suggests that the model explains all the variance in the data. The RMSLE value of 0.0006 indicates a small average logarithmic error. The MAPE value of 0.0005 suggests a small average percentage error. The training time is 0.0890 seconds.

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c) *Ridge Regression (Ridge)*

Table 3: Performance Parameters for Ridge Regression Model

Model Performance Parameters	Value
MAE	0.0101
MSE	0.0005
RMSE	0.0140
R^2	1.0000
RMSLE	0.0000
MAPE	0.0000
TT (Training Time)	0.0810 seconds

The Ridge regression model performs very well with a low MAE of 0.0101, indicating a small average absolute difference between predictions and actual values. The MSE and RMSE values are also low, indicating a small average squared difference and square root of the average squared difference. The R2 value of 1.0000 suggests that the model explains all the variance in the data. The RMSLE and MAPE values are close to zero, indicating low logarithmic and percentage errors. The training time is 0.0810 seconds.

d) *Lasso Least Angle Regression (LLAR)*

Table 4: Performance Parameters for LASSO Least Angle Regression Model

Model Performance Parameters	Value
MAE	0.1613
MSE	0.0589
RMSE	0.1998
R^2	1.0000
RMSLE	0.0006
MAPE	0.0005
TT (Training Time)	0.0460 seconds

The LLAR model performs similarly to the Lasso regression model, with a slightly higher MAE of 0.1613. The MSE, RMSE, R^2, RMSLE, and MAPE values are also comparable. The training time is 0.0460 seconds, which is relatively low.

e) *Bayesian Ridge (BR)*

Table 5: Performance Parameters for Bayesian Ridge Regression Model

Model Performance Parameters	Value
MAE	0.0000
MSE	0.0000
RMSE	0.0000
R^2	1.0000
RMSLE	0.0000
MAPE	0.0000
TT (Training Time)	0.0440 seconds

The Bayesian Ridge model achieves perfect performance, similar to the Linear Regressionmodel. The MAE, MSE, RMSE, R2, RMSLE, and MAPE values are all zero, indicating perfect predictions. The training time is 0.0440 seconds.

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f) Elastic Net (EN)

Table 6: Performance Parameters for Elastic Net Regression Model

Model Performance Parameters	Value
MAE	0.2196
MSE	0.2108
RMSE	0.3036
R^2	0.9998
RMSLE	0.0009
MAPE	0.0007
TT (Training Time)	0.0880 seconds

The Elastic Net model performs relatively worse compared to the previous models, with a higher MAE of 0.2196. The MSE and RMSE values indicate larger squared differences and square roots of the squared differences, respectively. The R^2 value of 0.9998 suggests that themodel explains most of the variance in the data. The RMSLE and MAPE values indicate small logarithmic and percentage errors. The training time is 0.0880 seconds.

Overall, the Linear Regression, Bayesian Ridge, and Ridge Regression models achieve perfect performance with zero errors. The Lasso Regression and Lasso Least Angle Regression models perform well with low MAE values. The Elastic Net model performs relatively worse in terms of MAE but still achieves a high R^2 value. The training times vary among the models but are generally quite fast, with the longest being 0.5810 seconds for theLinear Regression model.

V. Conclusion and Recommendations

This study illustrates a paradigm shift from traditional demand forecasting approaches to more sophisticated statistical methods and machine learning techniques. In line with these advancements, this study aims to improve existing knowledge on demand forecasting by utilizing an advanced Python library that simultaneously generates predictions using multiple regression algorithms. Additionally, the evaluation of the models' performance included various error analysis metrics such as MAE, MSE, RMSE, RMSLE, and MAPE. Among the models analysed, the first six models with smaller MAE and better predictions were selected for discussion. The remaining models, starting from Huber Regressor to Passive Aggressive Regressor, exhibited higher MAE values and less accurate predictions. The Linear Regression, Bayesian Ridge, and Ridge Regression models achieved perfect performance with zero errors across all performance metrics. The Lasso Regression and Lasso Least Angle Regression models demonstrated good performance with low MAE values. The Elastic Net model performed relatively worse in terms of MAE but still exhibited a high R^2 value, indicating a good level of explained variance. The training times varied among the models but were generally fast, with the longest training time observed for the Linear Regression model. This study builds upon previous research by employing advanced Python libraries and evaluating many regression algorithms simultaneously to improve demand forecasting. The selected models demonstrated varying levels of accuracy and computational efficiency. The findings highlight the effectiveness of non-linear techniques, such as Lasso Regression and Bayesian Ridge, in achieving accurate predictions with low errors. These results contribute to the growing body of knowledge on demand forecasting in supply chain planning and can aid decision-makers in improving their demand forecasting processes.

It is very important to know the study dataset was small and there is propensity for few models to produce R^2 of 1.0000. The case will be different where we have voluminous dataset. Perhaps, based on the analysis and results obtained in this study, several recommendations can be made to further enhance the demand forecasting process in supply chain planning:

1. Explore ensemble methods: Ensemble methods, such as Adaboost and the ensemble of Random Forest, have shown promising results in previous studies. It would be beneficial to investigate the potential of combining multiple regression algorithms to create an ensemble model that leverages the strengths of different approaches and produces even more accurate predictions.
2. Other machine learning techniques: While this study focused on regression algorithms, there are other advanced machine learning techniques that can be explored for demand forecasting. For example, deep learning models like recurrent neural networks (RNN) and long short-term memory (LSTM) networkshave been successful in capturing complex patterns in time series data. Investigating the application of these techniques may lead to improved forecastingaccuracy.

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By Hussain A. Al-Sadeg, Ali N. Al-Abbas & Mohammed A. Al-Saad

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Methodology: An integrative review approach was taken to synthesise the literature covering Industry 4.0 and the future of work skills. Saudi Aramco's Supply Chain Professional Development Program was conducted and subsequently findings from the literature were discussed.

Findings: A need exists for ups killing and reskilling supply chain management professionals. Organisations need to develop upskilling and reskilling programs for supply chain management professionals

Keywords: *industry 4.0, future of work skills, supply chain management skills, saudi aramco, article.*

GJMBR-A Classification: *LCC: HD38.5-70.7, JEL: M11*



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Hussain A. Al-Sadeg [α], Ali N. Al-Abbas [σ] & Mohammed A. Al-Saad [ρ]

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Originality: This research brings forth a discussion on the skills needed for supply chain management professionals in the energy industry in Saudi Arabia, which is a first of its kind, enabling new perspectives to emerge.

Keywords: industry 4.0, future of work skills, supply chain management skills, saudi aramco, article.

I. Introduction

This section provides a brief overview of the application of digital advancements in business practices. Advancements in technology have revolutionised the world. Innovative developments have reshaped the perceptions of work and the operation of industries. This latest revolution in business practices is commonly referred to as Industry 4.0 (Khan & Turowski, 2016). Industry 4.0 combines traditional manufacturing with cyber-physical systems, the Internet, the Internet of Things, and artificial intelligence (AI) to create intelligent production systems (Li, 2022). The impact of Industry 4.0 extends beyond production systems, which is reshaping the skills required by the workforce. Transformation is required in all job fields as more businesses embrace the latest digital revolution. This need is significant for supply chain management (SCM) professionals who are required to reimagine traditional practices and align them with the demands of Industry 4.0 (Karacay, 2018).

Saudi Aramco has taken steps to keep up to the advancements of Industry 4.0. Among the steps taken is the development of a business department named 'corporate digital factory'. The corporate digital factory is managing the production of digital solutions to Saudi Aramco organisations to have corporate intelligent production systems. These developments are impacting the general skills needed by Saudi Aramco's SCM professionals. Through the corporate digital factory, the SCM organisation is currently in the process of introducing Industry 4.0 solutions that can enhance the SCM operations. A study on the future work skills needed by Saudi Aramco SCM professional in response to Industry 4.0 changes is highly needed.

This study provides an analysis of the existing review of the skills required by SCM professionals. It further highlights the skills honed and employed by the professionals in Saudi Aramco and the future work skills required to meet the demands of Industry 4.0.

II. Literature Review

Several journals and websites were reviewed for information Industry 4.0, with emphasis on publications post COVID-19. The keywords utilised in the google scholar search engine were 'Industry 4.0', 'future of work skills', and 'SCM skills'. Other search engines did not produce relevant results.

a) *Impact of Industry 4.0*

This section investigates the skill transformation owing to various industrial revolutions, which significantly impacted people's jobs and how their work was performed. In the first industrial revolution in the 1700s, production was revolutionised with the use of steam power; thus, manual labour was replaced with machinery. During this time, production capacity improved from a single worker producing 20 pins a day to a factory producing as many as 4,800 pins per day. The second industrial revolution marked the advent of assembly lines. During this period, Henry Ford reduced the manufacturing time for magneto flywheels from 20 min to 5 min (Hannan and Kranzberg, 2023). The Third Industrial Revolution witnessed a shift from analogue and mechanical systems to digital systems driven by computers. This era saw the rise of automation and the dominance of machinery in job performance (Kumar and Kumar, 2020).

The innovations during each industrial revolution changed the skills needed for the workforce at that time. The Fourth Industrial Revolution was driven by four technological innovations: high-speed mobile

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Internet, AI and automation, big data analytics, and cloud technology. These advancements will affect all industries and make half of jobs vulnerable to automation. For example, multiple manufacturing and agricultural roles are already being phased out owing to increased automation (World Economic Forum Boston Consulting Group, 2018).

Industry 4.0 presents many challenges and opportunities simultaneously. One challenge is intensifying competition among businesses, as technological innovations help companies improve their productivity and efficiency. As these technologies are increasingly adopted by the businesses, it is significant for them to retrain their employees to acquire the necessary skills to leverage new technologies. Reskilling and upskilling are being implemented across businesses to adapt to the demands of technological innovation (Müller*et al*., 2018).

b) Future of Work Skills

The evolution of digital technologies is expected to disrupt the current skillsets required by the workforce. Businesses are developing and designing training programmes to improve their skills and reskill their workforce to adapt to current and future job demands. Upskilling is the acquisition of advanced skills through education and training (Merriam Webster, n. d.). Reskilling is defined as learning new skills to perform a different job (Cambridge Business English Dictionary, n. d.). It is estimated that six out of 10 workers will require additional training to meet future job demands by 2027. The businesses will have an opportunity to overcome the challenges of Industry 4.0 as they begin to invest in developing the skills of the workforce (Di Battista*et al.,* 2023).

The World Economic Forum (WEF, 2023) reports that 26 skills (Table I) are required to succeed in the future job market. These skills are divided into eight categories: technological skills, cognitive skills, engagement skills, management skills, physical abilities, self-efficacy, working with others, and ethics. Additionally, the WEF report highlights that technological literacy, leadership and social influence, analytical thinking, AI, and big data are prioritised by companies in the supply chain and transportation industry and in their reskilling and upskilling strategies (Table II). It is expected that 60% of the skills required by the SCM workforce will remain consistent by 2027 (Di Battista *et al.,* 2023).

Table I: The World Economic Forum Report on2023 future skills

Reskilling focus (2023-2027)	
1. Analytical thinking	14. Resource management and operations
2. Creative thinking	15. Marketing and media
3. AI and big data	16. Quality control
4. Leadership and social influence	17. Networks and cybersecurity
5. Resilience, flexibility and agility	18. Dependability and attention to detail
6. Curiosity and lifelong learning	19. Systems thinking
7. Technological literacy	20. Programming
8. Design and user experience	21. Teaching and mentoring
9. Motivation and self-awareness	22. Multi-lingualism
10. Empathy and active listening	23. Manual dexterity, endurance and precision
11. Talent management	24. Global citizenship
12. Service orientation and customer service	25. Reading, writing and mathematics
13. Environmental stewardship	26. Sensory-processing abilities

(Source: Di Battista et al. 2023, P. 42)

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Table II: Prioritised SCM Reskilling Focus Report

Prioritised SCM Reskilling Focus for 2023 – 2027
• Technological literacy
• Leadership and social influence
• Analytical thinking
• AI and big data
• Service orientation and customer service
• Creative thinking
• Resilience, flexibility and agility
• Motivation and self-awareness
• Curiosity and lifelong learning
• Empathy and active listening

(Source: Di Battista et al., 2023, p. 236)

The research by McKinsey Global Institute investigates the impact of automation, AI, and robotics on the skills needed for the future. The results show that the demand for certain high-level skills is predicted to increase, whereas it will gradually diminish for others. McKinsey identified 56 foundational skills that professionals need to succeed in the evolving job market as their future employability depends on them (Table III). An evaluation on proficiency across skills showed lowest scores for digital skills of 'software use & development' and 'understanding digital systems' (Dondi*et al*., 2021).

Table III: Mckinsey Report on Citizens'future Work Skills

Interpersonal	
Mobilizing system	**Developing Relationships**
– Role modeling	– Empathy
– Win-win negotiations	– Inspiring trust
– Crafting an inspiring vision	– Humility
– Organisational awareness	– Sociability
Teamwork Effectiveness	
– Fostering inclusiveness	
– Motivating different personalities	
– Resolving conflicts	
– Collaboration	
– Coaching	
– Empowering	
Cognitive	
Critical Thinking	**Mental Flexibility**
– Structured problem solving	– Creativity and imagination
– Logical reasoning	– Ability to learn
– Understanding biases	– Translating knowledge to different contexts
– Seeking relevant information	– Adopting a different perspective
	– Adaptability
Communication	**Planning and Ways of Working**
– Storytelling and public speaking	– Work-plan development
– Asking the right questions	– Time management and prioritization

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– Synthesizing messages	– Agile thinking
– Active listening	–
Self-Leadership	
Self-Awareness and Self-Management	
– Understanding own emotions and triggers	
– Integrity	
– Self-motivation and wellness	
– Self-control and regulation	
– Understanding own strengths	
– Self-confidence	
Entrepreneurship	
– Courage and risk-taking	
– Driving change and innovation	
– Energy, passion, and optimism	
– Breaking orthodoxies	
Goals Achievement	
– Ownership and decisiveness	
– Achievement orientation	
– Grit and persistence	
– Coping with uncertainty	
– Self-development	
Digital	
Digital Fluency and Citizenship	
– Digital literacy	
– Digital learning	
– Digital collaboration	
– Digital ethics	
Software use and Development	
– Programming literacy	
– Data analytics and statistics	
– Computational and algorithmic thinking	
Understanding Digital Systems	
– Data literacy	
– Smart systems	
– Cybersecurity literacy	
– Tech translation and enablement	

(Source: Dondi et al. 2021, P. 3)

c) Saudi Aramco's SCM Professional Development

SCM professionals' skills at Saudi Aramco were cultivated through a structured development program. The program was built around an internally developed set of SCM competencies. Competencies are routinely revised and updated to align workforce competencies with emerging business needs. More than 280 competencies exist for SCM and SCM-support functions in Saudi Aramco. The program is developed by a partnership between the SCM organisation and Saudi Aramco's professional development organisation. Through this program an advisor from professional development would facilitate the development of SCM competencies by working with SCM subject matter experts.

Table IV presents a simplified list of competencies utilised by Saudi Aramco's SCM professionals in their job roles. These roles vary across the SCM functions of procurement, logistics, and strategic sourcing. These skills are built into competency maps to develop targeted plans for different roles because SCM roles vary in complexity, with different proficiency levels (ordered from least to highest) as awareness, fundamental applications, skilled applications, and mastery.

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Table IV: Saudi Aramco SCM Development Competencies

Hard Skills	Soft Skills
– Budgeting	– Business Writing
– Compliance & Ethics	– Change Management
– Customer Relationship Management	– Communication
– Data Analysis	– Critical Thinking
– Enterprise Resources Planning (ERP)	– Negotiation
– Forecasting	– Problem Solving
– Health, Safety, Environment (HSE)	– Time Management
– Logistics Management	–
– Market Analysis	–
– Materials & Services Management	–
– Planning	–
– Policies & Procedures	–
– Reporting	–
– Strategy	–
– Supplier Relationship Management	–
– Supply Chain Optimization	–
– Value Stream Mapping	–
– Warehouse Management	–

Source: Saudi Aramco SCM Competencies Report

The SCM development program successfully developed the competencies required by the Saudi Aramco workforce. SCM professionals have individualised development plans to gain competencies needed for their growth in current and future roles. They are empowered by a comprehensive list of development methods for acquiring these skills. Development methods vary from formal to informal training, task and job assignments, professional certification, and so on. The outcome is a capable workforce that performs the tasks required of SCM professionals.

III. Discussion

An analysis of the literature on the future work skills of SCM professionals demonstrates the necessity for upskilling and reskilling programmes to focus on certain skills. Technological literacy and digital skills are the key skills required for SCM professionals and must be included in upskilling programs. Incorporating the development of these skills can vary between organisations. It is significant for organisations to determine the competency level required of their professionals in these skills and develop their programs accordingly.

According to WEF report the major reskilling focus will be on cognitive skills for future jobs. This indicates the importance of certain skills for the future workforce. These cognitive skills include leadership and interpersonal skills, which are important for supervisory and managerial roles in organisations.

As organisations move forward in developing programs for upskilling and reskilling, it is imperative for them to analyse the future skills required by their workforce. Organisations that fail to accurately assess their workforce skills to meet the market demands will likely fall behind the competition.

IV. Conclusion

In conclusion, for organisations to stay competitive in the future Industry 4.0 landscape, a review of their workforce skills is necessary. By focusing on the skills needed by SCM professionals, this study provides a foundation for the assessment of organisational upskilling and reskilling programs.

This study did not cover the available training and development opportunities for SCM professionals. A future research work can focus on the availability and efficacy of training and development programs for upskilling and reskilling SCM professionals. This study

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also informs the established SCM development program in Saudi Aramco.

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Threshold Concept for Promoting Business Transformation

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Abstract- This qualitative study highlights the importance of considering the threshold concept for promoting the business transformation of large-sized enterprises. The wide range of business literature and experts has debated how traditional large-sized companies can transform conventional approaches and mindset to be competitive. For example, many global enterprises now focus on digital transformation (DX), aiming to disrupt their conventional routines and adopt new DX knowledge and approaches. The literature on leadership identifies how a business leader should behave for their staff to transform their conventional approach, including promoting crisis awareness, setting up a clear strategy vision, and creating a DX department. However, without considering how to transform employees' conventional way of thinking at the individual level, a leader's action will be a unilateral announcement, and the company cannot promote company-wide transformation.

In order to get a clue for promoting the recent DX of large-sized traditional companies, this study is based on the past successful cases of two Japanese large-sized conservative companies that completed company-wide transformation and improved corporate business performance from financial haemorrhage in just a few years.

Keywords: *threshold concept, leadership, business transformation, business knowledge.*

GJMBR-A Classification: *LCC: HD58.8*



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Threshold Concept for Promoting Business Transformation

Yayoi Hirose

Abstract- This qualitative study highlights the importance of considering the threshold concept for promoting the business transformation of large-sized enterprises. The wide range of business literature and experts has debated how traditional large-sized companies can transform conventional approaches and mindset to be competitive. For example, many global enterprises now focus on digital transformation (DX), aiming to disrupt their conventional routines and adopt new DX knowledge and approaches. The literature on leadership identifies how a business leader should behave for their staff to transform their conventional approach, including promoting crisis awareness, setting up a clear strategy vision, and creating a DX department. However, without considering how to transform employees' conventional way of thinking at the individual level, a leader's action will be a unilateral announcement, and the company cannot promote company-wide transformation.

In order to get a clue for promoting the recent DX of large-sized traditional companies, this study is based on the past successful cases of two Japanese large-sized conservative companies that completed company-wide transformation and improved corporate business performance from financial haemorrhage in just a few years. The study suggests that, in order to promote corporate transformation, company leaders need to consider how their staff members and middle-managers overcome the threshold concept to learn transformative business knowledge at the individual level, instead of simply promoting crisis awareness and presenting a company goal. The study reveals the usefulness of the threshold concept for understanding transformative business knowledge, as it offers the ability to imagine a successful business scene by disrupting the conventional cognitive frame and adopting new values and approaches. The two cases suggest that by imagining a successful business scene, the employees were able to understand their concrete goal, learn transformative business knowledge, make huge efforts to attain their concrete goal, and ultimately improve their business performance. After overcoming the threshold concept, the employees, through a team effort, actively created their own business knowledge for transformation. This study thus suggests that business leaders who aim to promote DX in traditional companies should consider how company staff and middle-managers will be able to overcome the threshold concept for understanding transformative business knowledge.

Keywords: threshold concept, leadership, business transformation, business knowledge.

I. Introduction

Nowadays, many global enterprises aim to implement transformational projects. For example, they focus on how to implement DX systems, as DX is necessary for many enterprises to survive severe global competition (Rogers, 2016; Wade, 2019). They expect DX to transform and deepen their relationship with their stakeholders – such as customers, suppliers, and employees – by leveraging advanced digital technologies, including artificial intelligence and robotics, for their competitive advantage (Wade et al., 2019). In order to promote DX, it is necessary to transform employees' mindsets from a conventional approach, disrupting their conventional way of thinking and creating new business (Rogers, 2016; Wade, 2019). This study aims to discuss the usefulness of threshold concept to transform employees' mindsets from a conventional way of thinking.

In many global companies, the CEO has taken the leadership role in implementing a transformational system. As for DX, the CEO announces a clear strategy vision, which includes the message of why DX is necessary, organizes the DX department, and assigns the chief digital officer (CDO). The DX department is required to frequently communicate with business departments under the CDO's initiative to implement the DX system to transform their conventional operations and practices and launch a new business (Rogers, 2016; Wade et al., 2019). The leadership literature claims that a business leader who aims to transform a conventional organization should enable his/her staff and middle-managers to understand the necessity of disrupting the conventional approach and present them with a new business direction (Heifetz et al., 2009; Rogers, 2016).

However, companies that implement transformative business knowledge – including how to conduct a new strategic vision and make profit through the new projects – have not necessarily successfully transformed their organizations. Based on Gartner survey, although 87 per cent of senior business leaders state digitalization is a company priority, only 40% of organizations have brought digital initiatives to scale. Various studies from academics, business consultants, and analysts indicate that 70 to 95% of DX fail (Bonnet, 2022). While most organisations are doing digital projects, this does not mean they are a digital

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business. This means that a business leader needs to consider another factor in order to implement business knowledge. This study emphasizes the overcoming of the threshold concept as a successful factor to understand transformative business knowledge. In order to transform a company, organizational people need to disrupt their conventional ways of thinking and implement a new approach. However, as large-sized firms struggle with bureaucratic structures that sap initiative, they tend to maintain a conventional way of thinking; it is hard for them to understand new transformative business knowledge (Hamel & Zanini, 2018). This study discusses two key questions. First, what are threshold concepts to understand transformative business knowledge? Second, how can an organizational leader generate new business knowledge by collaborating with various stakeholders through an understanding of the threshold concept?

II. Literature Review

a) *Leadership for Transformation*

Past literature on leadership describes how a business leader should promote transformation. Heifetz et al. (2009) emphasizes that an executive leader should present the threat by continuing conventional business and evaluating challenges for adapting to a new environment. Kotter (1996) identifies the importance of promoting staff's crisis awareness, organizing collaborative teams for transformation, presenting a strategic vision, and encouraging staff initiative. The DX literature claims the importance of clarifying a strategic vision and organizing a new division for transformation (Rogers, 2016; Wade, 2019). Mintzberg (2004) stresses that a leader should first reflect on him/herself and frequently communicate with his/her front-line staff to take effective action for transformation.

Although this literature on leadership for transformation focuses on how a business leader ought to be and what a business leader should do (Heifetz, 2009; Hughes, 2016; Kotter, 1996; McKnight, 2013; Mitzberg, 2004; Rogers, 2016; Wade, 2019), it does not discuss how employees can transform their way of thinking or how they understand transformative business knowledge to the degree of actualizing the knowledge from an employee perspective. The leadership literature identifies the importance of communication with staff (Mintzberg, 2004), but it does not discuss what a business leader should consider in their communication with staff members to promote their understanding.

b) *The Threshold Concept*

The threshold concept was more developed in the field of school education rather than business solution (Barradell, 2013; Meyer & Land, 2003, 2005, 2006). Past discussion on threshold concepts focuses on how learners understand more complex knowledge that is not accessible to a novice, such as using a statistical lens to understand statistics (Beitelmal, et. al., 2022; Luoma, 2006; Meyer & Land, 2005). The discussion mainly addresses students learning technical, mathematical, and business material rather than learning organizational knowledge generated in a different cultural values (Bajada &Taylor, 2016; Chrispin, 2016; Hoatly, 2016).

The literature emphasizes that threshold concepts have five characteristics. They are gateway functions that prove troublesome for the learner to integrate with what they already know but, once learned, they are both transformative and irreversible. 'Transformative' refers to a complete and radical change in a learner's understanding, interpretation, and view of a phenomenon, topic, and/or practice (Meyer & Land, 2003; Meyer & Land, 2005). Threshold concepts completely alter the learner's view of the world and their way of thinking and behaving (Meyer & Land, 2005; Trafford, 2008). They change a learner's internal mental structures with respect to the way they perceive and interact with external reality (Yip & Raelin, 2011). This suggests that threshold concept can be helpful for employees who have conducted their business based on conventional approach to transform their way of thinking.

The concept is also irreversible. Once a learner has deeply embedded knowledge into their mindset, it is hard to unlearn because the conceptual framework used to interpret experiences has been reconfigured as a result of a novel integration of new thinking that applies to many phenomena (Davies & Mangan 2007; Meyer & Land, 2005). A threshold concept is also integrative in that it makes sense of and combines past knowledge through a different logic so that a learner can relate factors that have been previously hidden or separated (Meyer & Land, 2005). In this way, a threshold concept can enable learners to grasp and re-interpret the implications of previously tacit assumptions. Davies and Mangan (2007) argue that a threshold concept integrates past dimensions in complex ways by transforming conventional perception so that a learner cannot unlearn. When applying it to transformative business knowledge, it is important for employees to understand the threshold concept, as they are required to deal with tacit assumptions that they have already obtained.

Another characteristic of a threshold concept is that it acts as a gateway. It can be a portal or a step progression that enables a person to understand more complex knowledge that is inaccessible to a novice (Luoma, 2006; Meyer & Land, 2005). For example, Beitelmal, et. al (2022) argues that when a learner aims to understand statistics, he needs to have a statistical lens rather than a mathematical one; otherwise, the statistical concepts will not make sense. When an organizational leader aims to promote a transformational

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project, he/she needs to consider the gateway function, because they are novices in the field of transformation.

Finally, a threshold concept is troublesome because learners are being offered knowledge but cannot intuitively understand what it means in experience; it feels uncomfortable because it contradicts what they are familiar with and, at the initial stage, there is no sense of how to relate it to what they do know well (Meyer & Land, 2005; Perkins, 2006). Basically, it looks unfamiliar and alien, generating feelings of anxiety or tension as learners wrestle with the complexity of how to integrate it with knowledge that has worked well for them up until now (Cousins, 2006; McCormick, 2008; Perkins, 1999; Yip & Raelin, 2011). While the previous four points refer to cognitive dimensions, this difficulty is most connected to the emotional dimension of learning. Lucas and Mladenovic (2007) discuss how to make students understand new knowledge in pedagogical practice. They stress that a teacher needs to address the fundamental principles or assumptions for students to transform their conventional framework (Lucasa & Mladenovic, 2007). Students' preconceptions of new knowledge can be a barrier; for example, they tend to avoid understanding statistics because they think they cannot understand mathematics. Therefore, they first feel it to be troublesome before they even reach the gateway for understanding statistical knowledge (Lucas & Mladenovic, 2007). When learners think the concept is troublesome, they present emotions such as fear, concern for rejection, anxiety, tension, resentment, and worry (Lucas & Mladenovic, 2007).

Based on McKinsey survey, one of the serious reasons that make transformation fail is employee resistance. For organizational people, it is troublesome to transform their worldviews by challenging prior knowledge and information, as their organizational cultural context affects the recognition of business knowledge (Carlile, 2004). Nahavandi (2016) claims that a mindset that recognizes and accepts many cultures can be a threshold concept for management and leadership. He identifies the significance of self-assessment, reflection, and experience regarding global diversity to understand their own culture and the diversity of other cultures. However, although recognition of cultural diversity can be an important factor in understanding global management, organizational people will not intend to transform their mindsets to learn a new approach, as it is uncomfortable for the staff who have followed conservative norms and rules, and they do not recognize its necessity and value for improving their organizational performance (Hirose, 2022; Khoja & Maranville, 2010; Todorova & Durisin, 2007). Thus, it is necessary to explore another threshold concept to understand transformative business knowledge.

For employees who have been involved with conventional values and approaches for a long time, understanding the threshold concept can be effective for understanding transformative business knowledge. This is because, in order to promote organizational transformation, the learners (i.e., the employees) need to disrupt their conventional knowledge, completely transform their way of thinking, and create their own new business knowledge that integrates with the knowledge that has worked well for them up until now (Kotter, 1996; Heifetsz, 2009; Wade, 2019). Thus, a business leader needs to provide a gateway function for transformative business knowledge from an employee's perspective.

III. Case Study

This study discusses the threshold concept for Japanese business people to understand transformative business knowledge. In order to promote the recent DX, analysis on the past transformation projects can be helpful because transformation of employees' mindset is one of the most important factors for any types of transformation projects. It examines two traditional companies, Hitachi, Ltd. and Japan Air Lines (JAL), which showed a heavy deficit starting with the Lehman Shock in 2008. Hitachi, Ltd. recorded the largest deficit of Japanese manufacturing companies in 2009, and JAL filed for bankruptcy protection in January 2010. The business leaders of both companies implemented transformation projects and successfully turned business around within a short period (Inamori, 2015; Kawamura, 2015; Koitabashi, 2014). Table 1 summarized the two cases.

Table 1: Transformation of the Two Cases

	Number of employees before the transformation	Year of foundation	Circumstances	Goal of the transformation project (in terms of employees' mindset)
Japan Air Line	Around 47,600	1951	Filed for bankruptcy protection in January 2010	Impress the importance of making a profit and customer first principle
Hitachi	Around 330,000	1920	Recorded the largest deficit of Japanese manufacturing companies in 2009	Impress the importance of making a profit for each small unit of business.

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The reason this study examines Japanese traditional companies is because the norms and routines of Japanese companies are completely opposite of the direction in which transformation projects develop. Generally, Japanese traditional companies are based on conservative values, and their cultural values do not require clear goal setting which the leadership literature requires (Davis & Ikeno, 2002; Hirose, 2022). Historically, Japanese companies have struggled with disrupting conventional bureaucratic culture in order to be competitive. Business experts refer to *big company disease*: bureaucratic structures do not consider their customers and are unable to create new ideas because they have conventional and fixed ways of thinking (Tateishi, 2008). As Japanese traditional companies have been based on a bureaucratic seniority system, it takes a long time to make a decision, resulting in missed business opportunities (Kawamura, 2015; Parkinson, 1962, Tateishi, 2008; Yutani, 2008).

Although many Japanese business journals and books have criticized Japanese bureaucratic systems, including those of JAL and Hitachi, Ltd., it is hard for organizational people in Japanese companies to understand transformative business knowledge (Kaneko, 2017; Kawamura, 2015; Ogasawara, 2016). Both Hitachi, Ltd. and JAL are said to be successful cases of overcoming big company disease and implementing transformational business knowledge (Kaneko, 2017; Kawamura, 2015). There are various books and documents regarding how Hitachi, Ltd. and JAL successfully transformed, including statements by the CEOs at the time, middle managers, and staff members (Inamori, 2013; Kaneko, 2017; Kawamura, 2015; Shinko, 2020)

Many global enterprises are still struggling with transforming their conventional business thinking. Business departments resist transforming their conventional operations and practices. For example, in many companies, only one or two departments implement a DX system on a trial basis now, and the CEO cannot decide to launch a new DX business at the level of the entire company. Under these circumstances, the companies need an approach that enables the promotion of a transformational project. Such an approach requires organizational people to understand transformative business knowledge.

IV. Findings

The cases of Hitachi, Ltd. and JAL suggest that the threshold concept for understanding transformational business knowledge can be "the ability to imagine a successful business scene by disrupting the conventional cognitive frame and adopting new values and approaches". Organizational people tend to take actions based on their cognitive frames, which have been collectively generated in their organizations (Kaplan, 2008; Witt, 1998). As a result, in long-established organizations, many employees who have simply followed the conventional approach tend to focus on working based on conventional values (Tateishi, 2008). This is because following conventional norms and operations have made their business successful and their evaluations high. For example, the ex-CEO of JAL, Mr. Inamori (2015, p. 114), described the organizational situation when he became CEO in 2010: 'JAL staff did not recognize that JAL went bankruptcy as the airline continued regular operation even after JAL filed for bankruptcy protection'.

The ex-CEO of Hitachi Ltd., Mr. Kawamura (2015, pp. 89–90), referenced the difficulty of transforming employees' business when their business performance was going well: 'Even if I explain, "Because overseas companies become competitive, we will not be able to compete with them," the employees claim "we should not withdraw from this business because our business go well"'. He suggested that employees had difficulty in imagining the threat of a well-performing mature business being surpassed by new entrants. He stated that this is the most difficult issue when he aims to transform a company (Kawamura, 2015).

Past literature on leadership claims the importance of presenting the threat in continuing conventional business and evaluating challenging spirits for adapting to a new environment (Kotter, 1996; Wade, 2016). However, the two cases suggest that a leader unilaterally promoting crisis awareness does not necessarily mean that the employees can clearly imagine the urgent situation. Kaplan (2008) argues for the process of transforming cognitive frames through collective actions. However, organizational people who are used to conventional frames have a hard time understanding why it is necessary. They cannot understand why they need to disrupt their present approach. If they think they can still be successful using their conventional approach rather than a new one, they will not be able to disrupt the present business approach because they do not understand why they need to disrupt it and because it is stressful for business people to negate a successful way of thinking that had worked up to that point (Heifetz et al., 2009)

Marton et al. (2000) distinguish learning knowledge related to context from surface learning, where external knowledge is simply acquired and memorized, and the capacity to repeat what is known to others. In order to learn knowledge generated from a different value, learners need to understand the meaning of that knowledge in relation to their context, change their perspective of the world, and, as a result, change or transform the self (Marton et al., 2000). Thus, it is important to argue for the threshold concept, which considers how learners change their view of the world and their way of thinking (Meyer & Land, 2005; Trafford, 2008). Considering this situation, Mr. Inamori (2013)

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raised the awareness of employees by continuously and directly talking to them about deeply recognizing that JAL went into bankruptcy, reflecting on the reason, and addressing the reform.

The ability to imagine a successful business scene includes entrepreneurial imaginings about the business to be conducted and how to conduct it (Witt, 1998). For example, Mr. Kawamura stated:

> When I became a president of Hitachi company, I required the business unit leaders to set a benchmark, their competitors and present counteracts to their competitors. That is, they were required to explain their plan regarding how to increase their sales, such as the amount of increase in facility investment. Previously, the only executive management team members explain the company performance. So it was like a somebody's else's problem at that time. After I became a president, they were required to present their future successful business scene based on their concrete business data. Since then, they had a different look in their eyes and some business unit leader asked staff members to check the price of even small equipment. (Kawamura, 2016, pp. 52–53)

Mr. Inamori also claimed the importance of a concrete goal (Inamori, 2013; Shinko, 2020).

> Since we belonged to private company, we were required to make decision based on concrete data on our business performance. However, our staff rarely presented concrete data and they just presented very rough figure on our business a few months ago. Furthermore, it was not clear who own responsibility for what business. (Inamori, 2013, pp. 114).

He also required the employees and middle-managers to have a sense of ownership over their business, set a concrete goal, and make efforts to achieve the goal, no matter how the business environment changed (Inamori, 2013).

These successful cases suggest that organizational members should have a concrete image about their business performance. For successful business, organizational staff need to collectively share entrepreneurial business concepts rather than conventional business procedures and routines (Witt, 1998). Inamori (2012) claimed that JAL needed to change from bureaucratic norms and values to customer-first values and Amoeba management. Inamori created the Amoeba management system, in which small financially independent branches take responsibility for making their business profit. By implementing Amoeba management, the staff clearly imagined their goals and what they should improve in order to successfully achieve this goal (Shinko, 2020).

Through the reforms, JAL's middle managers' eyes sparkled and generated a sense of unity among the staff: 'We should have learned how we should act as a leader for customer-first and profit-oriented business much earlier to prevent JAL's bankruptcy. I would like to transfer this knowledge to my staff' (Inamori, 2013, p. 115).

The two cases illustrate how, when a leader focuses on carefully transferring the transformation's successful business image, the staff will be able to understand the image and take the transformative actions that the leader expects. For example, JAL middle managers collectively and actively created JAL's norms and business approach based on the successful image and shared them among all staff members (Inamori, 2013). The reason that new business knowledge was created was that most of the middle managers clearly understood their goal, so they were able to collectively create an approach for how to achieve this goal. As a result, JAL transformed into a customer-first company and in 2012 recorded a 17% profit ratio, which is miraculously high in the airline industry. Hitachi, Ltd. also achieved a record net profit in 23 years.

Table 2 summarizes the threshold concept for the transformative business knowledge of Hitachi, Ltd. and JAL and the business knowledge for transformation collectively created by employees and middle managers when the companies recovered from huge deficits.

Table 2: Threshold Concept and New Business Knowledge in Japanese Cases

	Transformative business knowledge	Threshold concept: The ability to imagine a successful business scene	New business knowledge collectively created by the middle managers and staff members
Hitachi, Ltd.	How to conduct a new strategic vision and make profit through the new transformative projects to reach the goal	Understand the goal, a concrete figure of profit at the business unit level	Report on business performance based on the new strategic discipline by each business unit
JAL	How to conduct a new strategic vision and make profit through the new transformative projects to reach the goal	Understand the goal, (1) a concrete figure of profit at the level of small independent branches and (2) customer-first service, which is highly evaluated	The 'JAL philosophy' regarding customer engagement and business strategy

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V. Discussion, Conclusion, and Limitation

This study highlights the importance of considering the threshold concept in the context of past discussions on business leadership, which emphasize the steps and actions a business leader should take from the viewpoint of a C-level leader. The fact that Over 70% of DX fail indicates that A leader unilaterally promoting crisis awareness does not necessarily mean that the employees can clearly imagine the urgent situation. While past literature on leadership tends to emphasize what actions a C-level business leader should take, this study presents the importance of considering employees' and middle managers' perspectives and promoting their understanding new business knowledge in corporate-wide transformative projects. By analysing the two cases of the past transformation project, this study presents the effectiveness of adopting threshold concept for transforming employees' mindset.

While the past discussions on threshold concept mainly focus on school education, this study contribute to extend the discussion to practical business projects. In order to promote transformation, a business leader needs to consider the individual level of employees and middle managers in overcoming the impediment to understanding transformative business knowledge. The findings show that employees who have belonged to large-sized traditional organizations have a hard time understanding transformative business knowledge, as they are used to bureaucratic organizational rules and norms. The threshold concept for business transformation can be the ability to imagine their successful business scene through transformation. Employees need to understand successful business scene, which can be their company's goal of the transformation, in detail. The study shows by understanding the threshold concept, they mastered how to conduct CEO's new business vision and make profit. By becoming able to collaborate with colleagues who similarly overcome the challenge and share the same understanding, middle managers and employees will be able to generate their own highly feasible business knowledge that supports their business transformation.

When business leaders aim to promote DX, they need to define a successful business scene more clearly. In the two cases of this study, where the purposes were to recover from the huge deficit, the successful business scene was easy to be imagined for employees based on a concrete profit figure. However, the DX goal can be more conceptual and not simply to achieve short-term profit, as DX strategy is related to company-wide long-term platform strategy (Rogers, 2016). This is the limitation of this study. Thus, further research is expected to clarifying threshold concept for employees' understanding of DX strategy

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Lean Six Sigma and Big Data Analytics: An Integrated Approach for Data-Driven Decision Making

By Ali K. Fardan

Abstract- This paper explores the integration of lean six sigma and AI technologies and how they can enhance each other's value. The paper introduces AI technologies such as Big Data Analytics, Data Mining and Machine Learning and explains how they can be applied within Lean Six Sigma frameworks. The paper also proposes a synergetic framework that combines AI tools and Lean Six Sigma methodologies. The paper is structured as follows. Section 1 is the introduction. Section 2 gives a brief overview of Lean Methodologies and their frameworks. Section 3 and 4 describe AI technologies, focusing on Big Data Analytics and Machine Learning (ML). Section 5 presents the synergetic framework that embeds AI tools into Lean Six Sigma (LSS) frameworks.

Keywords: *lean six sigma (LSS, artificial intelligence AI, big data analytics, machine learning (ML), DMAIC.*

GJMBR-A Classification: *FOR Code: 1503*



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Keywords: lean six sigma (LSS, artificial intelligence AI, big data analytics, machine learning (ML), DMAIC.

I. Introduction

In today's fast-paced and complex business environment, organizations need to find new ways to optimize their operations and stay ahead of the competition. Technology and innovation are key drivers of this transformation, and they require new management methods to leverage their potential. The convergence of Lean, Six Sigma, and AI technologies like Machine Learning and Big Data Analytics promises to revolutionize the way we approach strategy execution and propel organizations into a new era of operational excellence [1].

LSS aims at a capability level of 3.4 defects per million opportunities. Many businesses have attempted to implement LSS, but not everyone has succeeded in improving the business processes to achieve expected outcomes. [9]

The potential to integrate Lean Manufacturing to Industry 4.0 has been debated [3], and, more specifically, Lean Six Sigma has been investigated in its applications to accelerate the process of extracting key insights from Big Data, and how Big Data processing can help to innovate and cast a new light on the projects requiring the use of Lean Six Sigma [3].

In the context of Big Data Analytics, the law of large numbers is critical for understanding the selection of training datasets, test datasets, and in the evaluation of model skill. It supports the intuition that the sample becomes more representative of the population as its size is increased.

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For instance, if we collect more data, our sample of data will be more representative of the problem domain. As the size of the sample increases, the mean value of the sample will better approximate the mean or expected value in the population. As the sample size goes to infinity, the sample mean will converge to the population mean.

Analysis of massive data generated by IR4.0 technologies can't be done with usual Six Sigma statistical techniques. A more advanced Data Analytics algorithms and advanced statistical Machine Learning (ML) Models would produce more valuable information to support optimal decision making. New ML tools will not replace good LSS tools like DMAIC, PDCA, Pareto or fishbone diagrams, but will enhance them with more accurate inferential methods. Basic data mining techniques such as clustering, association, prediction, classification and process mining help organizations reach correct and optimal decisions at various stages of LSS projects.

Lean Six Sigma and Big Data Analytics are two complementary approaches that can enhance each other's capabilities and outcomes. Lean Six Sigma is a methodology that focuses on eliminating waste and variation in processes, while Big Data Analytics is a term that refers to the collection, analysis, and use of large and complex data sets. By combining Lean Six Sigma and Big Data Analytics, organizations can achieve powerful integration of data-driven insights and process improvement techniques. This can lead to improved quality, efficiency, innovation, and customer satisfaction.

Big Data Analytics can enhance Lean Six Sigma by providing tools for data analysis, process optimization, voice of customer, anomaly detection, predictive maintenance and more. Also, it can help to automate some of the tasks that are repetitive or tedious for humans, such as data collection, measurement and reporting [3].

However, such AI technologies also poses some challenges for Lean Six Sigma practitioners. For example, AI may require new skills and competencies to understand and interpret the results of machine learning models. AI may also introduce new sources of variation or bias that need to be identified and controlled [3].

The synergy between Lean, Six Sigma, and Big Data Analytics manifests itself in several ways, some of which are listed below [1]:

1. *Enhanced Decision-Making:* With AI's ability to process vast amounts of data and identify patterns,

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organizations can make more informed decisions that align with Lean and Six Sigma principles. For instance, AI can help interpret trends in data and identify outliers, enabling targeted improvements to eliminate waste and reduce variation.

2. *Predictive Analytics and Scenario Planning:* AI-driven predictive analytics can empower organizations to foresee potential issues and address them proactively. By leveraging AI in scenario planning, organizations can develop a playbook of potential issues and pre-planned responses, ensuring they are prepared for any eventuality.
3. *Continuous Improvement:* By integrating AI into Lean and Six Sigma initiatives, organizations can create a continuous improvement loop that constantly refines processes and performance.

II. LSS Methodologies

Lean Six Sigma methodologies are designed to eliminate waste, bottlenecks, and achieve total customer satisfaction. They combine the principles of lean manufacturing/lean enterprise and Six Sigma to optimize processes and improve quality [2].

Some of the techniques and tools used to implement Lean Six Sigma methodologies include:

1. *Kanban:* Workflow management practices, such as work visualization and limited work in progress, which maximize efficiency and promote continuous improvement [3].
2. *Kaizen:* Practices that engage employees and promote a work environment that emphasizes self-development and ongoing improvement [3].
3. *Value Stream Mapping:* Analyze places to eliminate waste and optimize process steps [3].
4. *DMAIC:* A data-driven five-phase problem-solving framework to six sigma projects. DMAIC is an acronym for five interconnected phases: Define, Measure, Analyze, Improve, and Control [3] [6].
5. *DMADV:* A five-phase framework for designing new products or processes that stands for Define, Measure, Analyze, Design, and Verify [3].

Lean Six Sigma methodologies (Table 1) follow a data-driven approach that relies on statistical analysis and measurement to identify root causes of problems and implement solutions. They also focus on delivering value to customers by understanding their needs and expectations. Approximately 95% of LSS projects follow to improve quality so-called define-measure-analyze-improve-control (DMAIC) approach [2].

DMAIC has proven to be one of the most effective problem-solving methods used up to now, because it forces the teams to heavily utilize the data [2]. Table 2 lists the DMAIC approach steps and sample activities. Table 3 lists all the tools utilized in the DMAIC five steps of which AI models are part of.

Table 1: LSS Methodologies Characteristics [4]

Characteristics	Methodologies			
	Lean	Six Sigma	Lean Six Sigma	Kaizen
Scope	Eliminating unwanted activities	Reducing variance	Waste elimination and variation reduction	Small and incremental changes
Objective	Reduction in workflow time	Process standardisation	Process standardisation and waste reduction	Incremental continuous improvements
Use of information technology tools	Very high	Very high	Very high	Intermediate
Relying on data in decisions making	High	High	High	High
Change method	One time	Incremental	Continuing	Continuing incremental
Associated risk levels	High	Moderate	Moderate	Moderate

Table 2: DMAIC Steps [2]

Phase	Descriptions	Sample activities
Define	Define the purpose and scope of the six sigma project	Define why the project should be done
		Define the targets, goals and scopes of project
		Define the customer requirements
Measure	Measure to determine the current situation	Select the output characteristics
		Assess the performance specifications
		Establish the initial process capability
Analyze	Analyze and determine the actual causes for process improvement	Analyze the current process performance
		Monitor the potential Critical to Process (CTP)
		Analyze what resources will be needed for improvement
Improve	Improve the process by eliminating wasteful causes, removing the problem or reducing the effects of the problem	Improve idea
		Identify optimal operating conditions
		Eliminate wastes
Control	Control the improved process performance	Determine the process capability for CTPs
		Implement the process controls
		Document what you have learned

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Table 3: Methods Used in LSS DMAIC Cycle [2]

	Define	Measure	Analyze	Improve	Control	Design	Verify
Statistics	Descriptive	Descriptive, Tally chart, Z-test, Confidence intervals, Predictive	Correlation, T-test, Chi-square test, F-test, Hypothesis tests, ANOVA, Histogram, Predictive	Hypothesis tests, Multivariate Analysis		Descriptive, Predictive	Correlation, Causality
Quality Tools	Brain storming, NGT, Pareto analysis, Matrix diagram, QFD, FMEA, SIPOC, Prioritization matrix, Fishbone analysis,	Pareto analysis, Process sigma	SPC	TRIZ, DOE	FMEA, Control diagram, Standardization, SPC	QFD, DOE	
Data Mining[3]			Association Rules, Clustering, Classification	Prediction		Market Basket Analysis, Association Rules	
Big Data	Text Mining, Video Mining		Machine Learning, Decision Trees, Text Mining, Video Mining, Artificial Intelligence	Machine Learning, Artificial Intelligence	Machine Learning, Artificial Intelligence		Machine Learning, Artificial Intelligence
Process Mining	Process Discovery	Conformance checking	Process Discovery, Conformance checking	Flow diagrams, Enhancement	Flow diagrams, Conformance checking		Graphing, Visualization

III. AI: Big Data Analytics

Data is created constantly, and at an ever-increasing rate. Mobile phones, social media, imaging technologies to determine a medical diagnosis- all these and more create new data, and that must be stored somewhere for some purpose. Devices and sensors automatically generate diagnostic information that needs to be stored and processed in real time. Merely keeping up with this huge influx of data is difficult, but substantially more challenging is analyzing vast amounts of it, especially when it does not conform to traditional notions of data structure, to identify meaningful patterns and extract useful information. These challenges of the data deluge present the opportunity to transform business, government, science, and everyday life.

Big data analytics is the process of using advanced techniques and tools to analyze large and complex datasets and extract useful information from them.

The Big Data trend is generating an enormous amount of information from many new sources. This data deluge requires advanced analytics and new market players to take advantage of these opportunities and new market dynamics. [10]

Some of the Big Data types include:

1. *Structured Data:* This is data that has a predefined format and can be easily stored and processed in databases or spreadsheets. Examples of structured data are customer records, sales transactions, sensor readings, etc.
2. *Unstructured Data:* This is data that has no fixed format and is often text-based or multimedia. Examples of unstructured data are emails, social media posts, videos, images, audio files, etc.
3. *Semi-Structured Data:* This is data that has some elements of structure but also contains unstructured components. Examples of semi-structured data are XML files, JSON files, web logs, etc. Chart 2 below presents a depiction of data evolution and the rise of Big Data Sources.

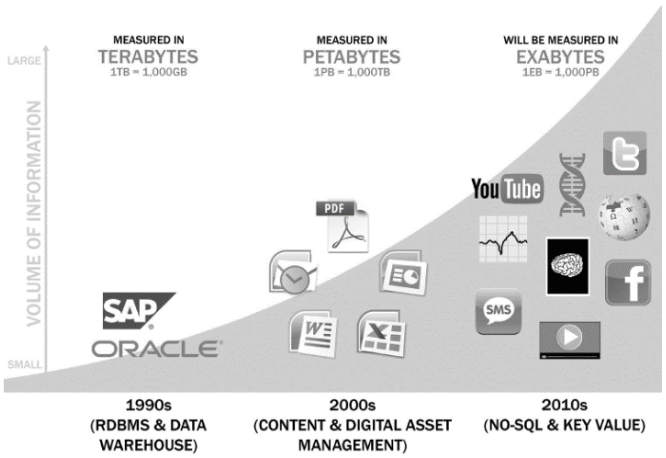

Chart 2: Data Evolution and the Rise of Big Data Sources [10]

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Big Data Analytics process follows a five lifecycle phases. Here is a brief overview of the main phases:

- *Phase 1- Discovery:* In Phase 1, the team learns the business domain, including relevant history such as whether the organization or business unit has attempted similar projects in the past from which they can learn. The team assesses the resources available to support the project in terms of people, technology, time, and data. Important activities in this phase include framing the business problem as an analytics challenge that can be addressed in subsequent phases and formulating initial hypotheses (IHs) to test and begin learning the data.
- *Phase 2- Data Preparation:* Phase 2 requires the presence of an analytic sandbox, in which the team can work with data and perform analytics for the duration of the project. The team needs to execute extract, load, and transform (ELT) or extract, transform and load (ETL) to get data into the sandbox. The ELT and ETL are sometimes abbreviated as ETLT. Data should be transformed in the ETLT process so the team can work with it and analyze it. In this phase, the team also needs to familiarize itself with the data thoroughly and take steps to condition the data
- *Phase 3- Model Planning:* Phase 3 is model planning, where the team determines the methods, techniques, and workflow it intends to follow for the subsequent model building phase. The team explores the data to learn about the relationships between variables and subsequently selects key variables and the most suitable models.
- *Phase 4- Model Building:* In Phase 4, the team develops datasets for testing, training, and production purposes. In addition, in this phase the team builds and executes models based on the work done in the model planning phase. The team also considers whether its existing tools will suffice for running the models, or if it will need a more robust environment for executing models and workflows (for example, fast hardware and parallel processing, if applicable).
- *Phase 5- Communicate Results:* In Phase 5, the team, in collaboration with major stakeholders, determines if the results of the project are a success or a failure based on the criteria developed in Phase 1. The team should identify key findings, quantify the business value, and develop a narrative to summarize and convey findings to stakeholders.
- *Phase 6- Operationalize:* In Phase 6, the team delivers final reports, briefings, code, and technical documents. In addition, the team may run a pilot project to implement the models in a production environment.

IV. AI: Machine Learning (ML)

Machine learning is a branch of artificial intelligence (AI) that enables machines to learn from data and improve their performance without explicit programming [2]. Machine learning can be used to analyze big data and refine operations by identifying patterns, trends, anomalies, and correlations [3].

The machine learning model takes the featured data, as inputs, and examines them against a supervised machine learning approach or cluster them in unsupervised approach. The model then labels the input and recommends an action against each activity.

Lean Six Sigma can benefit from Machine Learning/Big Data Analytics by using it to:

- Enhance forecasting and decision making by using variance models and statistical analysis algorithms.
- Automate routine tasks and optimize workflows by using robotic process automation (RPA) and natural language processing (NLP).
- Improve customer satisfaction and loyalty by using sentiment analysis and recommendation systems.
- Consolidate critical success factors and best practices by using classification and clustering algorithms.

Machine learning/ Big Data Analytics can also benefit from Lean Six Sigma by using it to:

- Define clear objectives and metrics for machine learning projects by using DMAIC frameworks.
- Measure and monitor the performance of machine learning models by using control charts and dashboards.
- Analyze and improve the quality of data and models by using value stream mapping and root cause analysis.

Machine learning analytical methods are utilized to analyze big data and produce results. The output of machine learning models is the result of applying a trained algorithm to a given data set. Machine learning models are used to recognize patterns in data or make predictions based on the learned information. A machine learning model is defined as the mathematical representation of the real-world processes that are approximated by the algorithm. Different types of machine learning models are suited for different tasks, such as classification, regression, clustering, or recommendation. Some examples of machine learning models are support vector machines, decision trees, neural networks, and k-means clustering. These models are utilized during Big Data Analytics phase 3, model planning. Big data is fed into machine learning algorithms to analyze and for predicting output results. Big Data Analytics and Machine Learning are complementary fields that work together to teach machines how to recognize patterns in complex datasets and make valuable predictions.

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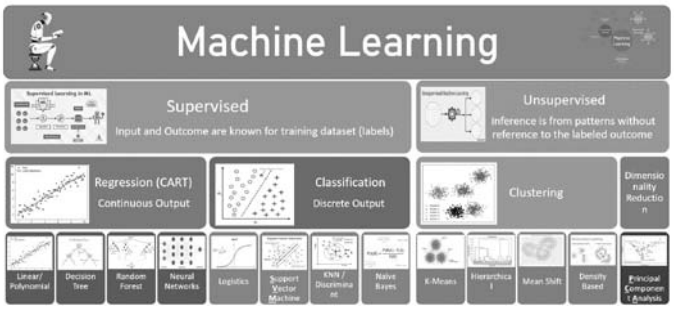

Chart 1: A Simplified Representation of Common Machine Learning Algorithms

V. The Synergy: Integrated Approach

The presence of synergies between Lean Management Tools and Big Data Analytics is evident and therefore, the combination of Lean Management Tools and Big Data Analytics will bring significant benefits to the organizations. [5]

DMAIC and other process improvement methodologies greatly benefit from statistical methods of which Big Data helps providing accurate prediction close to the intended results.

In an integrated approach, Big Data Analytics can be used to train models on large datasets. The law of large numbers supports this by ensuring that as we collect more data, our sample becomes more representative of the population and our model's accuracy improves. These accurate models can be utilized at various stages of LSS projects.

DMAIC and other process improvement framework constituents can be categorized into the following phases: Process Discovery, Process Behavior Measurement/Prediction, Process Improvement and Process Optimization. In each phase various Big Data Analytics algorithms can be utilized to increase the quality/ accuracy of the phase outcome bringing the aim of reaching 3.4 defects per million. The table below lists the recommended ML/Big Data Analytics algorithms to each phase of LSS project.

Table 4

Phase	DMAIC Phase	Data Analytics Life Cycle	Tools/Algorithms
Process Discovery	Design	• Discovery • Data Preparation • Model Planning	• SQL • Exploratory Data Analysis EDA • Data Visualization • Data Wrangling • Outliers Detection • Correlation & Regression Models • Prediction based on History
Process Behavior Measurement/ Prediction	Measure Analyze	• Model Design & Building	• Support Vector Machine (SVC) • Clustering • Association Rule • Regression • Decision Tree • Naïve Bayes Classifier • Time Series Analysis • Text Analysis
Process Improvement	Improve	• Communicate Results	• Data Visualization • Explanatory Graphs • Scatterplot • Heatmap • Maps • Quality Control Charts
Process Optimization	Control	• Operationalize	• Linear Programming • Network Models • Decision Trees • Simulation, Monte Carlo, Next-Event Approach

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Data Analytics life cycle phases can be mapped into LSS projects and accordingly utilize the available advanced tools to increase the quality/ accuracy of each LSS phase output.

VI. Conclusion

The aim of this paper was to present a comprehensive overview of how Lean Six Sigma and Big Data Analytics can be integrated to enhance the quality decision making process. Lean Six Sigma is a quality improvement methodology that focuses on reducing variation and waste in processes, while Big Data Analytics is the process of applying advanced techniques to analyze large and diverse datasets that contain various types of data. In the context of industry 4.0, where massive amounts of data are generated and available, traditional data analysis techniques used in Lean Six Sigma projects may not be adequate. Therefore, by combining both methodologies, quality projects can benefit from more effective and efficient decisions for quality problems. This paper proposed a framework for aligning or synthesizing the different stages of both methodologies, and suggested some algorithms and techniques that can be used in each stage. However, this paper did not provide detailed explanations of these algorithms and techniques, nor did it illustrate their applications with real-world case studies. These could be topics for future research or papers that could further enrich the subject and demonstrate its practical value.

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The Impact of Corporate Social Responsibility on Employees of Manufacturing Firms in Nigeria

By Debo Adedeji

Abstract- In recent years, multiple authors have explored the connection between Corporate Social Responsibility (CSR) activities and employee performance, specifically in regards to employee engagement, commitment and satisfaction. This study examine the impact of CSR on the employees' performance in the Nigeria manufacturing sector. Social exchange theory which posited that reciprocity plays a crucial role in shaping relationships within organizations was used to underpin the study. Descriptive statistics inform of frequency count, and percentage will be applied to analyze the research questions formulated in this study while inferential statistics in form of regression analysis was employed to test the hypotheses postulated in this study. Findings showed a significant effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector. Result also indicated a significant impact of CSR on employees' commitment in the Nigeria manufacturing sector. Analysis also showed that there was a significant impact of CSR on employees' satisfaction in the Nigeria manufacturing sector.

Keywords: corporate social responsibility, engagement, commitment, satisfaction, employee, manufacturing sector.

GJMBR-A Classification: JEL Code: M14

THE IMPACTOFCORPORATESOCIALRESPONSIBILITYONEMPLOYEESOFMANUFACTURINGFIRMSINNIGERIA

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Keywords: corporate social responsibility, engagement, commitment, satisfaction, employee, manufacturing sector.

I. Introduction

The manufacturing sector in Nigeria is striving to thrive and overcome the various challenges in the current competitive market by enhancing their organizational efficiency [17, 16 and 18]. To achieve better results and increase profit margins, firms in the sector are implementing various cutting-edge business tools and management approaches, such as corporate social responsibility, employee engagement, and employee satisfaction [1]. As companies are facing mounting pressure from stakeholders to become more socially and environmentally responsible and to focus on understanding the impact of engaged employees on business outcomes like productivity and profitability [22], corporate social responsibility has become a crucial issue for corporations globally [24]. Both customers, investors, and other stakeholders, as well as business organizations, have shown interest in corporate social responsibility because it is believed that engaging in socially desirable activities can positively impact a firm's financial performance [19]. Additionally, Ali et al. [1] indicated that the interest in corporate social responsibility also arises from the fact that it strengthens the bond between employees and corporations and leads to better employee and organizational performance.

Manufacturing firms are striving to be more mindful of their performance by placing emphasis on employee performance. In this regard, they seek individuals who will go beyond their assigned job duties, foster teamwork, and assist their colleagues, employers, and clients [13]. Employee engagement is seen as a critical concern for companies who consider their workforce as their most valuable asset [10]. Nonetheless, leaders are aware of the various obstacles that hinder employee engagement. But organizations that can overcome these challenges have great potential for growth, particularly in terms of business performance [14]. Disengaged employees can negatively impact productivity and profitability [12] [15]. Therefore, organizations must cultivate an environment that encourages employee involvement and implement strategies that maintain this involvement to secure exceptional organizational performance.

II. Statement of the Problem

In recent years, multiple authors have explored the connection between Corporate Social Responsibility (CSR) activities and employee performance, specifically in regards to employee engagement, commitment and satisfaction. The studies have suggested a positive correlation between the constructs [20, 25, 24, 6, 15, 16]. Further research and understanding is necessary in regards to the relationship between corporate social responsibility, employee engagement, commitment and satisfaction, particularly in developing countries such as Nigeria. This paper seeks to investigate the impact of corporate social responsibility on employees of manufacturing firms in Nigeria in relation to employees' engagement, commitment and satisfaction. The paper will endeavour to answer the following questions:

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1. What is the effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector?
2. What is the impact of CSR on employees' commitment in the Nigeria manufacturing sector?
3. What is the impact of CSR on employees' satisfaction in the Nigeria manufacturing sector?

III. Research Hypotheses

The following research hypotheses will be used to guide the study:

Ho1: There is no significant effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector

Ho2: There is no significant impact of CSR on employees' commitment in the Nigeria manufacturing sector

Ho3: There is no significant impact of CSR on employees' satisfaction in the Nigeria manufacturing sector

IV. Objective of the Study

The main objective of this study is to examine the impact of CSR on the employees' performance in the Nigeria manufacturing sector. The specific objectives are to:

1. Observe the effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector.
2. Examine the impact of CSR on employees' commitment in the Nigeria manufacturing sector.
3. Ascertain the impact of CSR on employees' satisfaction in the Nigeria manufacturing sector.

This study focuses on the impact of CSR on the employees' performance in the Nigeria manufacturing sector. The study is centered on the male and female employees of the Nigeria manufacturing sector. However, the study makes use of 30 manufacturing firms' headquarters in Lagos state out of the six South west states in Nigeria (Lagos, Osun, Ogun, Ondo, Ekiti and Oyo states). Lagos state is chosen because it remains the industrial hub of the Southwest region of Nigeria where employees in the state are educated and conversant with CSR in the region.

V. Literature Review

a) Corporate Social Responsibility (CSR)

Corporate Social Responsibility (CSR) refers to the voluntary actions taken by a company to address social and environmental issues that go beyond its legal obligations. CSR encompasses various activities such as community involvement, employee relations, ethical sourcing, environmental sustainability, and philanthropy [1]. The concept of CSR has gained widespread attention in recent years due to increased awareness of the social and environmental impact of businesses. CSR is believed to enhance a company's reputation and contribute to long-term financial success [8, 6, 15,16, 17]. Furthermore, CSR has become an important consideration on for consumers, investors, and other stakeholders who are increasingly looking for companies that align with their values (Carroll, 1991). Organizations have realized that embracing a socially responsible approach to their operations is crucial. This understanding stems from the various social, economic, legal, ethical, and environmental issues that organizations must navigate, and the realization that solely focusing on economic management to achieve goals is no longer viable [16]. In addition, organizations are facing pressure from a multitude of stakeholders, including communities, regulators, NGOs, activists, socially responsible investors, etc., to act as responsible corporate citizens [4]. As noted in [7], organizations engage in corporate social responsibility for multiple reasons, all of which help enhance their financial portfolio.

Organizations have the ability to engage in various forms of corporate social responsibility, such as promoting a positive work environment for employees, being considerate towards investors, being environmentally conscious, upholding ethical standards, showing respect for communities, and supporting causes such as the arts and universities [15]. [16] suggests that organizations can demonstrate social responsibility by being environmentally responsible, treating employees fairly, and contributing to cultural and arts programs in the community. Engaging in socially responsible activities brings many benefits to organizations, such as improving relationships with stakeholders by reducing conflicts and increasing loyalty [8]. It can also enhance corporate reputation, reduce organizational costs by creating positive social impacts and reducing negative ones, align corporate and social values, identify new opportunities, and lead to positive performance results. There are various methods used to evaluate a company's level of corporate social responsibility. One approach proposed dividing CSR into four categories: economic, legal, ethical, and discretionary. Another suggested examining CSR from the viewpoint of different stakeholders. Additionally, some scholars have proposed categorizing CSR practices into internal and external social responsibilities (as cited in references 18, 12, and 22), however, internal CSR will serve as the basis for measurement in this study.

b) Internal CSR

Internal corporate social responsibility (CSR) encompasses all aspects of a company's internal operations [22]. It concentrates on enhancing the well-

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being and productivity of employees, which ultimately impacts the organization's profitability [22]. Internal CSR practices refer specifically to those initiatives aimed at improving the physical and psychological working environment for employees [12]. As employees are regarded as crucial internal stakeholders, the focus on them is crucial for the success of the organization [20]. According to [24], internal CSR practices can be divided into four categories, known as "value classes," which address employee development, social justice, health and safety in the workplace, worker satisfaction and well-being, and work quality.

c) CSR Toward Employees

The socially responsible actions of an organization that are specifically aimed at employees are more likely to have a significant impact on their performance due to their exclusive focus on employee welfare. Such activities, such as fair treatment, professional development opportunities, and consideration of employee needs and opinions, create a positive work environment and increase the employees' sense of organizational support. Research supports this, with a study by Liu et al., [18] finding that socially responsible HR practices positively influence employee behavior through increased organizational identification. Similarly, [18] found a strong correlation between a company's perceived social responsibility toward employees and job performance.

d) Employee Engagement

In today's constantly evolving business world, company leaders have come to understand the importance of having a high-performing workforce for the success and longevity of their organizations. This has led to employee engagement becoming a crucial focus for companies as a highly engaged workforce has been shown to boost innovation, productivity, and financial performance, as well as lower the costs associated with hiring and retaining top talent [14]. The term was first introduced into academic literature by [19], who suggested that personal engagement occurs when individuals bring their personal selves into or exclude them from their work roles [20] defined employee engagement as a positive outlook that employees have towards the organization and its values. In this definition, engaged employees are well-informed about the company's context and work collaboratively with their colleagues for the benefit of the organization. Studies have shown that organizations with high levels of employee engagement are also more likely to have a strong CSR commitment [14]. Engaged employees are more likely to support and participate in CSR initiatives, and they are also more likely to align their personal values with the values of the organization [14]. Moreover, a strong CSR culture can positively impact employee engagement by creating a sense of purpose and meaning in the workplace [19].

e) Employee Commitment

Employee commitment is an essential aspect of organizational success, as it is associated with various positive outcomes, including improved job satisfaction, higher levels of productivity, and reduced turnover [7]. Commitment can be influenced by various factors, including the organization's policies and practices, as well as the employees' perceptions and attitudes towards the organization. Research has indicated that employees who work for organizations with strong CSR practices tend to have higher levels of commitment and job satisfaction [18]. For example, a study by [18] found that employees who worked for organizations with a strong CSR orientation were more likely to be engaged and committed to their work, and less likely to consider leaving the organization. Moreover, employees who perceive their organizations as socially responsible are more likely to be proud of their organization, and to recommend it to others [21]. This, in turn, can positively impact the organization's reputation and overall performance.

f) Employee Satisfaction

Employee satisfaction is a critical component of organizational success, as it affects employee motivation, productivity, and overall job performance (Robbins & Judge, 2007). Corporate Social Responsibility (CSR) is a term used to describe a company's commitment to operating in an ethical and responsible manner, taking into account the impact of its activities on stakeholders, including employees [16]. Studies have shown that CSR activities positively impact employee satisfaction. For example, research by McDonald and Galbreath (2009) found that employees who perceived their employers to be engaged in CSR activities had higher levels of job satisfaction and organizational commitment. Additionally, a study by [19] found that employees who work for organizations with a strong commitment to CSR tend to have higher levels of job satisfaction and lower levels of burnout. Furthermore, CSR initiatives can help foster a sense of purpose and belonging among employees, leading to increased job satisfaction. For instance, a study by Lindgreen and Swaen (2010) found that employees who work for companies that engage in CSR activities feel more connected to their organization and have a stronger sense of purpose.

VI. Theoretical Framework

a) Social Exchange Theory

This study is hinged on the social exchange theory. The social exchange theory, originally put forth by Blau in 1964, states that reciprocity plays a crucial role in shaping relationships within organizations. If an

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organization treats its employees with fairness, kindness, and care, employees are likely to respond in kind. Over time, this mutual exchange of positive behavior leads to the development of trust, loyalty, and commitment. To better understand this social exchange relationship, the concepts of leader-member exchange and trust have been studied. Leader-member exchange refers to the relationship between employees and their supervisors or leaders, while trust refers to the exchange relationship between employees and their employers and immediate supervisors.

b) Conceptual Framework

Figure 1: depicts the conceptual model for the study. It is observed from the study CSR has a direct effect on employees' performance. This could be observed with three arrows that directly pointing from the internal CSR to the employees' engagement, employees' commitment and employees' satisfaction.

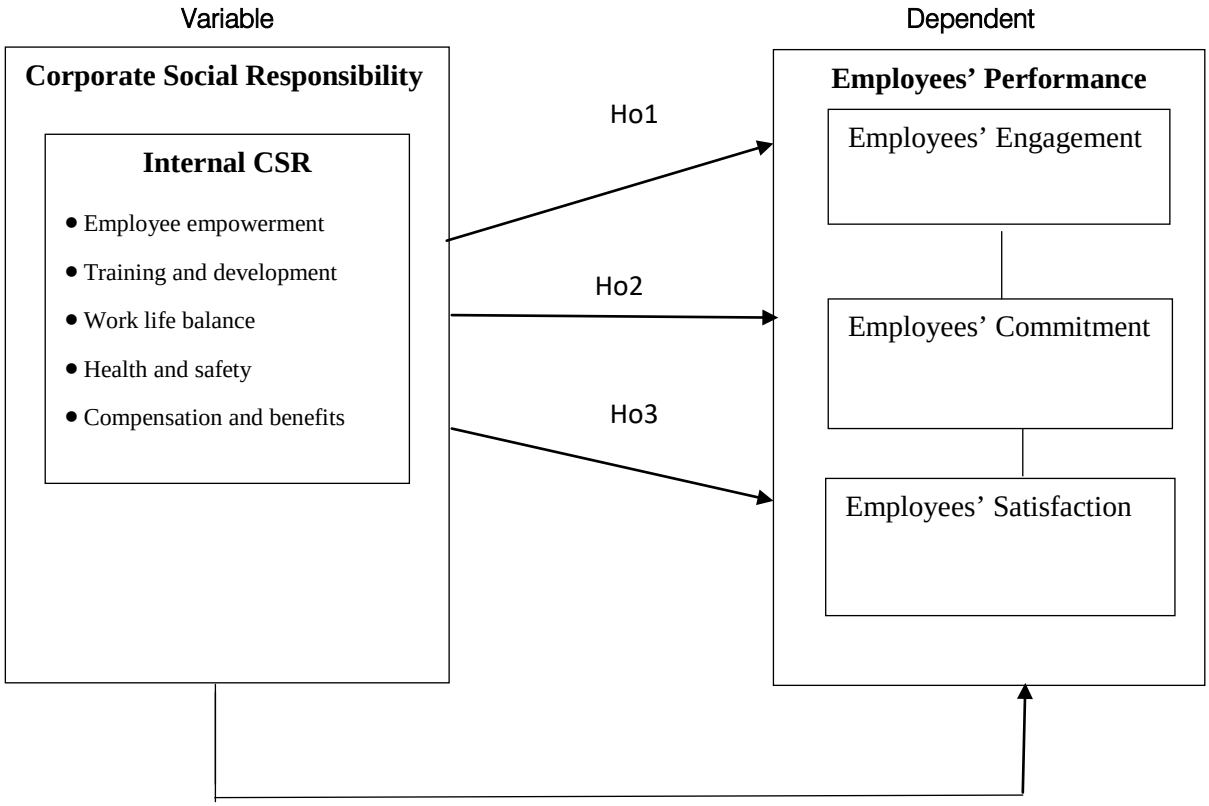

Figure 1: Conceptual Model Independent Variable

VII. Research Methodology

This study will apply deductive approach by employing descriptive research survey which has to do with specific predictions, narration of facts, characteristics concerning individual, group or situation. Descriptive statistics inform of frequency count, and percentage will be applied to analyze the research questions formulated in this study while inferential statistics in form of regression analysis was employed to test the hypotheses postulated in this study. Descriptive research survey is preferred because it enabled the researcher to collect data and information with efficiency and make concrete recommendations. Survey research design was employed to gather information and data relating to the impact of CSR on the employees performance from the manufacturing firms in Nigeria. Thirty manufacturing firms were selected and 30 employees were selected from each firm. Therefore sample size consists of 300 employees from various manufacturing firms in Nigeria. The data collection method used is a customized questionnaire which has two parts. The first part includes demographic and personal information, while the second part is based on a Likert scale ranging from "strongly agree" to "strongly disagree." The aim is to examine the impact of CSR internal factor on employee performance, taking into account the effect on employees' engagement, commitment and satisfaction.

a) Reliability and Validity Tests

Table 3 displays the outer model's construct validity and reliability as evaluated in our study. The table presents the values of construct reliability and average variance extracted (AVE), both of which indicate the convergent validity of our constructs. The results demonstrate that all variables have a construct reliability

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greater than the acceptable standard of 0.7 for internal consistency. Additionally, each construct's average variance extracted value is greater than 0.5, indicating that the data is convergent valid. (Hair et al., 2017)

VIII. Data Analysis

The dependability of a measurement is determined by its ability to produce consistent results when conducted under the same conditions. If a questionnaire produces highly consistent answers during testing, it can be considered a reliable tool. On the other hand, if the results vary significantly, the instrument is considered unreliable. One method of determining internal consistency is through Cronbach's Alpha test, which yields a coefficient score. A coefficient between 0.60 and 0.70 is considered to have fair reliability, while a coefficient between 0.70 and 0.80 is considered good reliability. A coefficient greater than 0.80 is considered excellent reliability. It is important to note that for research purposes, a minimum alpha coefficient of 0.70 is recommended.

Table 1: Construct Reliability and Convergent Validity

Constructs	No. of Items	Mean	Std. Deviation	Construct, Reliability	Average Variance Extracted (AVE)
CSR and Engagement	8	3.54	0.53	0.834	0.562
CSR and Commitment	7	3.38	0.69	0.839	0.511
CSR and Satisfaction	7	3.55	0.58	0.824	0.549

Table 2 displays the discriminant validity of the data using Fornell and Larker's (1981) method. The diagonal values show the square root of the average variance extracted, while the remaining values indicate the correlations between the variables. All diagonal average variance extracted values exceed the correlations, demonstrating the presence of discriminant validity in the data.

Table 2: Discriminant Validity

	CSR and Engagement	CSR and Commitment	CSR and Satisfaction
CSR and Engagement	0.75		
CSR and Commitment	-0.134	0.715	
CSR and Satisfaction	0.253	0.075	0.741

IX. Data Analysis and Discussion

a) Demographic Characteristics of the Population Studied

Three hundred (300) questionnaires was administered and were correctly filled and retrieved in good condition and subject to analysis through SPSS (22.0). The demographic distribution is as follows:

i. *Distribution of Sample by Gender*

Respondents were asked to indicate their gender in order to understand the percentage of male and female workers in the study area.

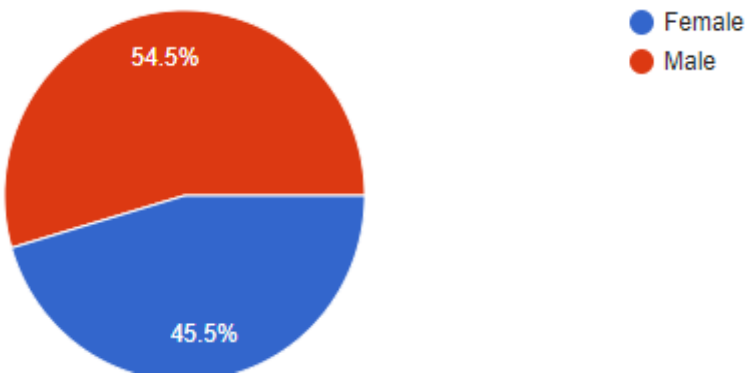

Figure 2: Distribution of Sample by Gender

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Figure 2 above demonstrates the gender distribution of the respondents. The data shows that 45.5% of the respondents were female, while 54.5% were male. This suggests that there is a higher number of male employees in the study area than female. However, the percentage of female respondents indicates that there is a reasonable representation of women in the Nigerian workforce, despite the predominance of men in the manufacturing sector.

ii. *Distribution of Sample by Age*

Respondents were also implored to indicate the category of age which they belong to and this was represented in the figure 3 below:

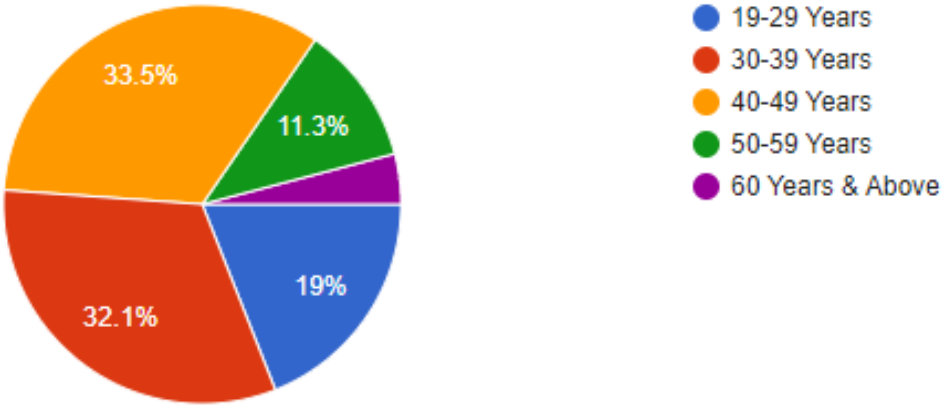

Figure 3: Distribution of Sample by Age

As depicted in figure 3 above, the age group with the highest percentage of respondents was between 40 to 49 years. This suggests that most of the participants belonged to the working class in the manufacturing sector and were still in their active years to contribute towards production.

iii. *Distribution of Sample by Education*

Respondents indicated their level of literacy according to the certificate obtained. This is presented in figure 3.

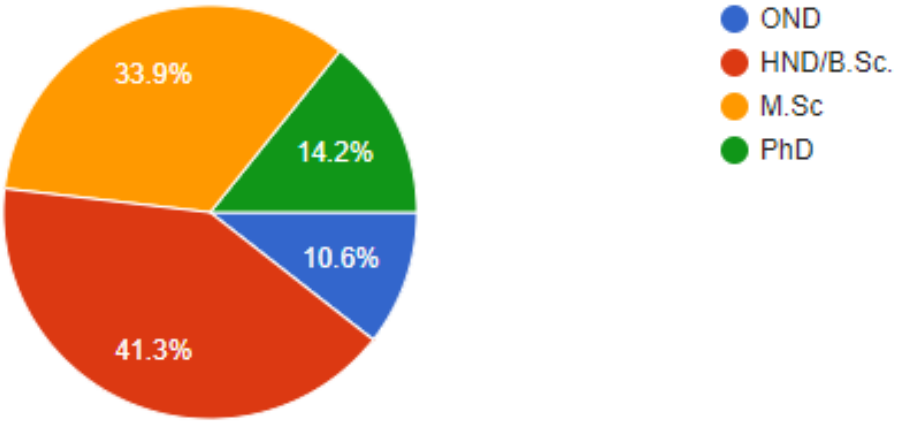

Figure 4: Distribution of Sample by Education

The education distribution of the respondents is illustrated in Figure 4 above. The data reveals that out of the 300 participants who completed the research instrument accurately, 41.3% possessed a higher level of education, including Higher National Diploma (HND) and/or Bachelor of Science (BSc.). This is closely followed by 33.9% of respondents who had obtained a Master of Science (M.Sc.) degree. Furthermore, 14.2% of participants held a Ph.D. while a smaller proportion (10.6%) possessed an Ordinary National Diploma (OND). These results indicate a high level of literacy among the respondents, which is likely attributed to the study area's metropolitan and elitist nature and the abundance of educational facilities.

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iv. *Distribution of Sample by Years of working Experience*

Respondents were also asked to indicate their years of working experience. This is represented in figure 4 below:

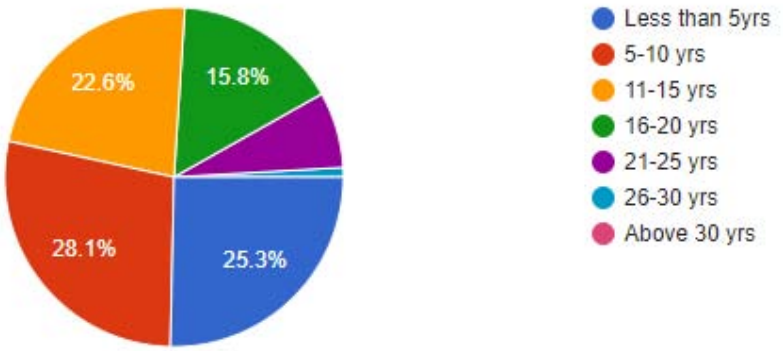

Figure 5: Years of Working Experience

Figure five reveals that 28.1% of the participants had a work experience of over 5 years in the study location, whereas 25.3% of them had a job tenure of under 5 years. Additionally, 22.6% of the respondents had worked in the companies for more than 11 years, and 15.8% had a working experience of 16-20 years. Therefore, it can be inferred that the majority of the participants had been earning a salary from the companies for a minimum of 5 years due to their long-term job tenure in the study area.

b) Descriptive Statistics

This analysis is simplified and understandable by constituting the research and analysis into three factors. These three factors, in line with the research questions, are as follows:

1. What is the effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector?
2. What is the impact of CSR on employees' commitment in the Nigeria manufacturing sector?
3. What is the impact of CSR on employees' satisfaction in the Nigeria manufacturing sector?

i. *Research Question One*

What is the effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector?

The percentage responses from the participants were aggregated based on the four Likert scale of strongly agree, Agree, Disagree and Strongly Disagree. This is represented in the chart below:

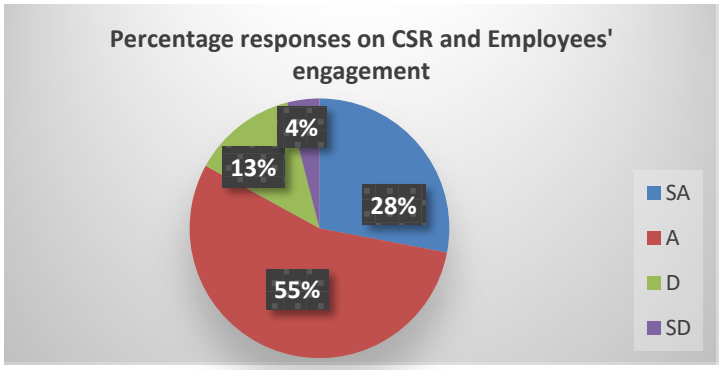

Figure 6: Percentage Responses on CSR and Employees' Engagement

It is indicated in figure 6 above that more than half of the employees agreed that corporate and social responsibility has a large effect on the engagement of the employees in the Nigeria manufacturing sector.

ii. *Research Question Two*

What is the impact of CSR on employees' commitment in the Nigeria manufacturing sector?

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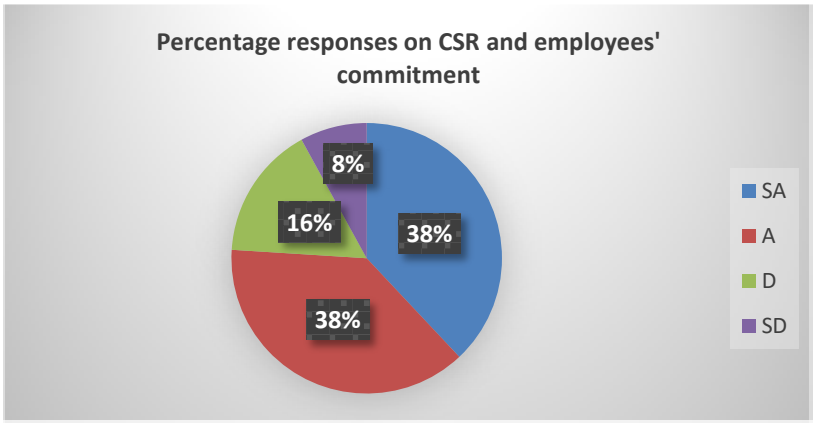

Figure 7: Responses on CSR and Employees' Commitment

It is also observed from figure 7 above that CSR has a larger effect on employees' commitment in the Nigeria manufacturing sector with higher percentage strongly agree and agree to the statement

iii. *Research Question Three*

What is the impact of CSR on employees' satisfaction in the Nigeria manufacturing sector?

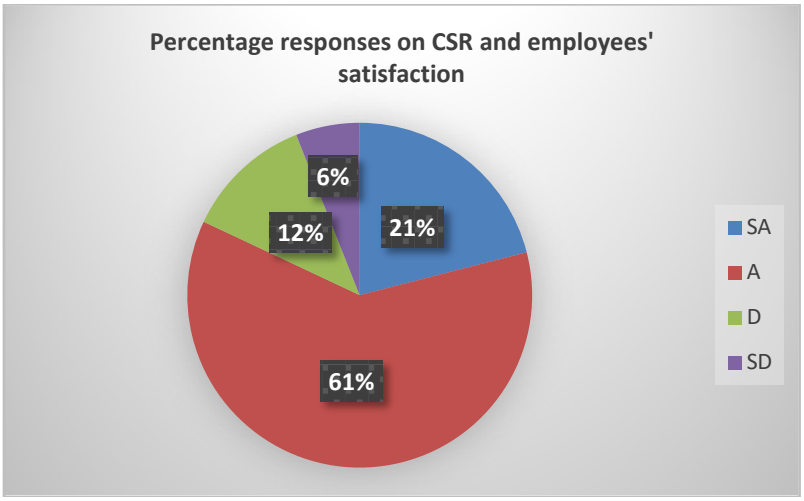

Figure 8: Responses on CSR and Employees' Satisfaction

Figure 8 indicate a large effect of CSR on the employees' satisfaction in the Nigeria manufacturing sector with higher percentage agreed to the assertion.

X. Testing of Hypotheses

Result of the hypotheses is presented in table 3 below. Regression analysis was run to test the following research hypotheses:

Ho1: There is no significant effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector

Ho2: There is no significant impact of CSR on employees' commitment in the Nigeria manufacturing sector

Ho3: There is no significant impact of CSR on employees' satisfaction in the Nigeria manufacturing sector

Therefore, the results of the hypotheses were combined in table 3 below

Table 3: Structural Model Results

	Coefficients	Standard Deviation (STDEV)	T Statistics	P-Values	5%	95%
CSR -> Engagement	-0.219	0.051	4.317	0.00	-0.307	-0.119
CSR -> Commitment	0.251	0.041	6.096	0.00	0.168	0.327
CSR -> Satisfaction	0.118	0.051	2.309	0.02	0.021	0.214

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Table 2 presents a comprehensive display of the direct and indirect regression paths, alongside their respective levels of significance and standard deviation values for all variables. As per the first hypothesis, the initial pathway is from corporate social responsibility to employee engagement, indicating a positive and significant direct correlation at $p<0.001$ (H1 accepted).

Similarly, the table reveals that the p-value for the second hypothesis, which asserts the effect of corporate social responsibility on employee commitment, is 0.000, which falls below the significant threshold of 0.05. This demonstrates a clear and positive relationship between CSR and employee commitment.

The results presented in Table 2 demonstrate a noteworthy effect of CSR on the satisfaction of employees. This is corroborated by the p-value of 0.02, which is below the critical threshold of 0.05.

XI. Discussion

This study explores the impact of corporate social responsibility on the employees performance in relation to engagement, commitment and satisfaction of the employees in the Nigeria manufacturing sector.

Further, the paper explored whether CSR had significant impact on the employees' engagement, commitment and satisfaction in the Nigerian manufacturing sector. It is observed from the findings that there is significant effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector. This finding is supported by the findings of [14] who found out that a strong CSR culture can positively impact employee engagement by creating a sense of purpose and meaning in the workplace. Finding is also similar to that of [19] who found out that engaged employees are more likely to support and participate in CSR initiatives, and they are also more likely to align their personal values with the values of the organization.

The study also showed that there is significant impact of CSR on employees' commitment in the Nigeria manufacturing sector. This is in line with that of [18] who found that employees who worked for organizations with a strong CSR orientation were more likely to be engaged and committed to their work, and less likely to consider leaving the organization. Moreover, employees who perceive their organizations as socially responsible are more likely to be proud of their organization, and to recommend it to others according to [21].

The study also showed that there was significant impact of CSR on employees' satisfaction in the Nigeria manufacturing sector. This finding corroborates with the research by [18] who found that employees who perceived their employers to be engaged in CSR activities had higher levels of job satisfaction and organizational commitment. Finding is also in line with that of a study by [19] who found that employees who work for organizations with a strong commitment to CSR tend to have higher levels of job satisfaction and lower levels of burnout. Furthermore, CSR initiatives can help foster a sense of purpose and belonging among employees, leading to increased job satisfaction.

XII. Conclusion

The basis of this research is founded on the social exchange theory discussed previously. The theory proposes that reciprocal actions have a significant impact on the relationships formed within organizations. When an organization treats its staff with equity, benevolence, and concern, it can expect a similar response from its employees. This ongoing exchange of positive behavior eventually leads to the cultivation of trust, allegiance, and dedication. According to the study's results, the implementation of internal corporate social responsibility serves as a vital measure of management's attentiveness to the well-being and safety of employees. Workers are able to detect these signals and offer their support in appreciation for the well-intentioned actions carried out on their behalf. By demonstrating corporate social responsibility and showing care and concern for employees, trust is established, leading to higher employee engagement, commitment and consequently employee satisfaction. However, inadequate employee support undermines the intended moderating effect, failing to influence employee behavior towards the development of trust in the organization or its leaders. This highlights the prioritization of activities directly impacting individual employees over those involving external stakeholders or colleagues in the Nigeria manufacturing sector, potentially due to lower economic status and Nigeria's status as a developing nation. Studies have revealed that the existence of organizational trust and positive social connections between supervisors and their subordinates have a significant impact on an employee's perception of a safe work environment and their psychological empowerment [24, 22 and 20]. This, in turn, allows employees to exhibit extra-role behaviors, such as work engagement, commitment and voice behavior. Regrettably, in countries like Nigeria, where an authoritarian and bureaucratic approach is prevalent, employees lack faith in their supervisors and leaders, which diminishes the influence of such positive relationships on their work behavior.

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Appendix

Research Instrument

Section A: Demographic Data

Gender: Male [ ]; Female [ ]

Age: 19-29 years [ ]; 30-39 years [ ]; 40-49 years [ ]; 50-59 [ ]; 60 years and above [ ]

Service Tenure Years: 1.3 years [ ]; 4-6 years [ ]; 7-9 years [ ]; 10 years and above

Educational Qualification: Below BSc. [ ]; BSc [ ]; Masters [ ]; PhD [ ]

Section B: Statement on effect of corporate and social responsibility on the engagement of the employees in the Nigeria manufacturing sector

S/n	Statement	SA (Strongly Agree)	A (Agree)	D (Disagree)	SD (Strongly Disagree)
1	Corporate and social responsibility positively affects employee engagement	30%	60%	10%	0%
2	Employees are more motivated to work for socially responsible companies	20%	60%	15%	5%
3	Socially responsible companies have higher employee retention rates	25%	55%	15%	5%
4	Corporate responsibility initiatives can improve employee morale	35%	50%	10%	5%
5	Companies with a strong social responsibility focus have a better reputation among employees	40%	45%	10%	5%
6	Corporate responsibility positively impacts employee job satisfaction	30%	50%	15%	5%
7	Companies with a strong social responsibility focus attract and retain top talent	25%	55%	15%	5%
8	Socially responsible companies tend to have more loyal employees	20%	60%	15%	5%

Section C: Statement on relationship between CSR and employees' commitment in the Nigeria manufacturing sector

S/n	Statement	SA (Strongly Agree)	A (Agree)	D (Disagree)	SD (Strongly Disagree)
1	Implementing CSR initiatives can enhance employee morale and job satisfaction	45%	40%	10%	5%
2	Companies that prioritize CSR are more likely to attract and retain talented employees	35%	45%	15%	5%
3	CSR initiatives can increase employees' sense of pride and loyalty towards their employer	40%	40%	15%	5%
4	Companies that engage in CSR are perceived as more socially responsible and ethical, leading to increased employee trust and commitment	50%	35%	10%	5%
5	CSR initiatives that benefit the community and environment can make employees feel like they are part of a larger purpose and mission	45%	40%	10%	5%
6	Lack of investment in CSR can negatively impact employee engagement and commitment	10%	20%	45%	25%
7	Employees who feel that their employer is socially responsible are more likely to be motivated and committed to their job	40%	45%	10%	5%

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Section D: Statement on the relationship between CSR and employees' satisfaction in the Nigeria manufacturing sector

S/n	Statement	SA (%)	A (%)	D (%)	SD (%)
1	CSR activities positively impact employee job satisfaction in the Nigeria manufacturing sector.	25%	60%	10%	5%
2	CSR initiatives can enhance employee satisfaction to their organization in the Nigeria manufacturing sector.	20%	65%	10%	5%
3	CSR activities can improve employee morale in the Nigeria manufacturing sector.	22%	60%	12%	6%
4	CSR programs can increase employee satisfaction in the Nigeria manufacturing sector.	18%	62%	15%	5%
5	CSR activities can contribute to creating a positive corporate culture in the Nigeria manufacturing sector.	24%	58%	11%	7%
6	CSR initiatives can lead to a more positive perception of the company by employees in the Nigeria manufacturing sector.	21%	60%	12%	7%
7	CSR activities can positively impact employee retention in the Nigeria manufacturing sector.	19%	61%	14%	6%

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Tips for writing a good quality Management Research Paper

Techniques for writing a good quality management and business research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of management and business then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



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6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.
Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.



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- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.



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Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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