

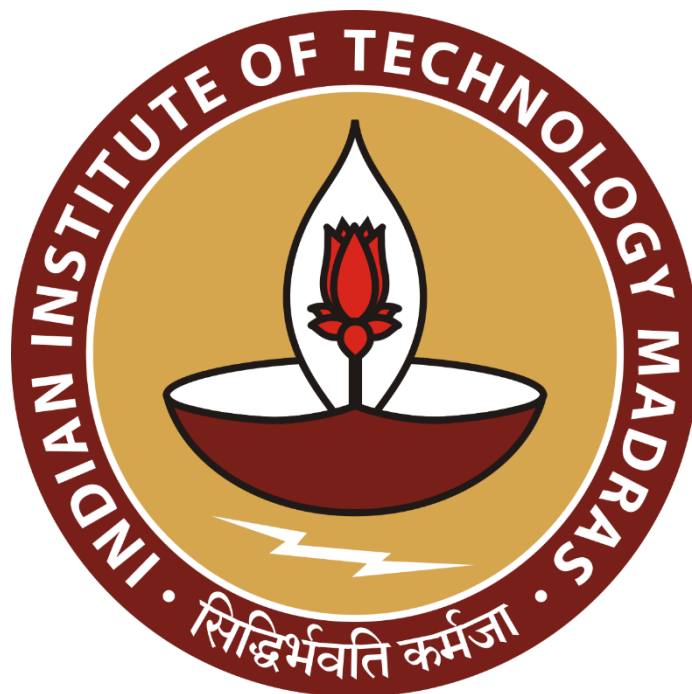
Optimizing Printer Head Maintenance and Manpower Deployment in Smart Card Production

A Final report for the BDM capstone Project

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1 Executive Summary

Bonton Softwares Private Limited is a medium-sized IT organization specializing in printing smart cards and driving licenses for the government. They have over 10 years of experience in software development and software support services, with more than 500 employees working in the company. The company mainly focuses on government verticals. They have been experiencing challenges due to an increase in damaged printed cards and are looking to determine the necessary workforce for each Regional Transport Office (RTO).

The primary objective of the project is to optimize workforce and printer head utilization. The report provides a detailed explanation of the methods used to analyze the data for both issues, along with the collection of relevant data. It also includes a basic explanation of the data variables. Identifying gaps and areas for improvement in the current strategy is crucial. The report will feature an in-depth analysis of the collected data to identify patterns, enabling us to determine the necessary manpower for each process and the required quantity of printer heads.

The project report will focus on providing recommendations to address the identified problem areas after conducting a comprehensive analysis. It will include detailed recommendations for manpower requirements based on demand and head requirements for each region. The analysis will be carried out using tools such as Excel and Google Colab. This report will explain the results and findings using bar graphs, line charts, Pareto charts, and other necessary graphs. By analyzing the performance of both the outperforming and underperforming RTOS with these Excel tools, we can formulate recommendations and data-driven decisions to optimize manpower and printer head requirements.

2 Detailed Explanation of Analysis Process/Method

2.1 Data used for analysis:

I gathered raw data from the organization, personally obtaining it from an email sent by the senior business analyst. After cleaning and preparing the data, I will be using Excel and Google Collab for the analysis. Meta data that I have collected for analysis is shown in table 1.

	Jan-23								Feb-23						
OFFICE	DL SUCCESS	DL DAMAGE	RC-NT SUCCESS	RC-NT DAMAGE	RC-T SUCCESS	RC-T DAMAGE			DL SUCCESS	DL DAMAGE	RC-NT SUCCESS	RC-NT DAMAGE	RC-T SUCCESS	RC-T DAMAGE	
CHENNAI (CENTRAL)	1620	0	1388	3	199	0			1940	6	2098	1	351	3	
CHENNAI (NORTH WEST)	2099	8	1657	13	244	16			2128	11	2852	4	398	0	
CHENNAI (NORTH EAST)	1904	2	1511	1	327	0			2290	9	2021	0	382	15	
CHENNAI (EAST)	1309	4	1033	8	310	2			1574	1	1269	5	414	4	
CHENNAI (NORTH)	2496	19	2880	6	503	1			3057	8	3776	2	645	0	
POONAMALEE	2496	15	3856	1	662	3			2700	11	5174	5	871	0	
AMBATTUR	1818	3	2406	2	254	0			1923	7	2484	0	274	0	
REDHILLS	1460	2	2269	24	614	14			1710	2	3070	2	739	0	
GUMIDIPOONDI	266	0	399	1	105	1			335	2	697	1	168	0	
THIRUVALLUR	786	2	1229	0	240	4			858	5	1625	3	248	1	
TIRUTHANI	369	1	457	0	74	0			363	1	536	2	76	0	
CHENNAI (SOUTH EAST)	2082	1	4115	1	228	0			2292	5	4170	2	206	0	

Table 1 Meta Data

Descriptions for Column Variables:

- DL- SUCCESS - Number of Driving License Cards successfully Printed
- DL-DAMAGE- Number of Driving License Cards Damaged
- RC-NT SUCESS- Number of RC Cards for Non-Transport Vehicle Successfully Printed
- RC-NT DAMAGE - Number of RC Cards for Non-Transport Vehicle damaged
- RC-T SUCCESS - Number of RC Cards for Transport Vehicle Successfully Printed
- RC-T DAMAGE Number of RC Cards for Transport Vehicle damaged

The meta data I have collected is a time series data. The meta data contains monthly quantities of printed and damaged cards in each RTO, along with information on the number of employees and printers in each RTO. Additionally, I have details on the consumption of printer heads over the past few months, excluding printed head consumptions. All the data, except for printer head consumptions, covers the period from January 2023 to June 2024. I also collected number of printers available at each center. Number of employees working at each center also collected. For printer head only five-month data is given by the company for the analysis. To access the raw file and cleaned meta data click the provided link below,

Raw Data: [DATA FILE](#)

Meta Data: [META DATA FILE](#)

2.2 Descriptive statistics:

We need to analyze the total number of cards printed and damaged from January 2023 to June 2024. In order to calculate these numbers, the following formulas were utilized:

$$\textbf{\textit{TOTAL CARDS PRINTED}} = \textbf{\textit{DL SUCCESS}} + \textbf{\textit{RC}} - \textbf{\textit{NT SUCCESS}} + \textbf{\textit{RC}} - \textbf{\textit{T SUCESS}}$$

$$\textbf{\textit{TOTAL DAMAGED CARDS}} = \textbf{\textit{DL DAMAGE}} + \textbf{\textit{RC}} - \textbf{\textit{NT DAMAGE}} + \textbf{\textit{RC}} - \textbf{\textit{T DAMAGE}}$$

Furthermore, determining the average number of cards printed and damaged can provide valuable insights into the demand for each RTOS. This analysis can also help identify which RTOs experience higher instances of damaged cards each month. The formulas for calculating the average number of cards successfully printed or damaged are as follows:

$$\textbf{\textit{AVERAGE NUMBER OF CARDS PRINTED}} = \frac{\textbf{\textit{TOTAL NUMBER OF CARDS PRINTED}}}{18}$$

$$\textbf{\textit{AVERAGE NUMBER OF DAMAGED CARDS}} = \frac{\textbf{\textit{TOTAL NUMBER OF DAMAGED CARDS}}}{18}$$

I have calculated the total fraction to determine the demand for the number of cards that need to be produced. After obtaining the total fraction, I multiplied it by 294 to calculate the excess manpower required. Since the manager specified that 3 employees are assigned to each RTO, I assumed that 1 employee is mandatory for every office and excluded 146 from the total number of employees to find the excess manpower required. Then, I added 1 employee to the excess manpower to obtain the total manpower required. It's important to note that the total fraction method was used solely to understand the demand for each RTO, and it will not be considered as the final recommendation for the manpower requirement.

$$\textbf{\textit{Total Fraction}} = \frac{x_i}{\sum_i^n x_i}$$

- x_i : the i -th number of data point from total cards printed
- n : number of data points total number of cards printed

2.3 Man Power Optimization:

In order to assess the current productivity of the organization, it is imperative to initially compute the total number of cards printed for all Regional Transport Offices (RTOs) for each

month. Subsequently, the current productivity of each month can be determined using the following formula.

$$\text{Current Productivity} = \frac{\text{Total Number of Cards printed Each month}}{N * Z}$$

where,

$Z = \text{number of employees}$

$N = \text{Number of RTOs}$

The manager specified that three employees are assigned to each RTO, with a total of 146 RTO centers. To determine the productivity of each employee, we divide the total number of cards printed each month by 438. Then, we calculate the average productivity from January 2023 to June 2024 to assess the productivity level of each employee.

In order to determine the number of extra cards that need to be printed, one must assign one employee for every RTOs. This calculation involves assuming the average current productivity as the optimal productivity for one employee and using a specific formula.

$\text{EXTRA CARDS NEEDS TO BE PRINTED} =$

$\text{AVERAGE NUMBER OF CARDS PRINTED} - \text{ONE EMPLOYEE'S OPTIMAL PRODUCTIVITY}$

In order to ascertain the additional manpower required for each RTO, the formula below is utilized, taking into consideration the extra cards that need to be printed

$$\text{EXTRA MAN POWER RQUIRED}(Y_i) = \frac{M}{I}$$

$$\text{TOTAL MAN POWER REQUIRED}(X_i) = Y_i + 1$$

$$s.t : X_1 + X_2 + \dots + X_{146} \leq 438$$

Where,

$M = \text{EXTRA CARDS NEEDS TO BE PRINTED}$

$I = \text{ONE EMPLOYEE'S OPTIMAL PRODUCTIVITY}$

$X_i = \text{TOTAL MANPOWER REQUIRED}$

2.4 Total Head Consumption:

First, I am going to explore whether there is a relationship between the total number of cards printed and the total number of damaged cards. If there is a strong correlation between these two variables, we can predict the demand for card printing in each region by determining the

demand for the total headcount in that region. The correlation coefficient formula is provided below,

$$P_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}$$

- x_i = number of cards printed
- \bar{x} = mean of cards printed
- y_i = number of cards damaged
- \bar{y} = number of cards damaged

To start, the number of head consumptions for each month from January 2024 to May 2024 will be calculated. This will be used to determine the average number of cards that can be printed by a single printer head. The formula for calculating the average number of cards that can be printed by a single head is provided below:

$$\text{NUMBER OF CARDS A SINGLE HEAD CAN PRINT} = \frac{\sum_{JAN}^{MAY} X_i}{H}$$

WHERE,

$$X_i = \text{TOTAL NUMBER OF CARDS PRINTED IN } i\text{th MONTH}$$

$$H = \text{TOTAL NUMBER OF HEADS CONSUMED}$$

To calculate total heads required first we assume 1 head assigned for all regions. Extra head that required for each region is computed as by below formula,

$$\text{EXTRA HEADS REQUIRED} = \frac{\text{AVERAGE CARDS PRINTED MONTHLY EACH REGION}}{\text{NUMBER OF CARDS A SINGLE HEAD CAN PRINT}}$$

$$\text{TOTAL NUMBER OF CARDS PRINTED} = \text{EXTRA HEADS PRINTED} + 1$$

To ensure smooth printer operation, the company wants to calculate the Reorder Point, Safety Stock, and EOQ using the provided assumed values.

Assumptions:

- Order Cost Per Order $S=22000\text{rs}$
- Holding Cost Per Unit Per Year $=10000\text{rs}$
- Z-score $=1.645$
- Lead time $=14$ days (0.5months)

Standard deviation of demand during lead time

The formulas to determine the optimal quantity of the head are,

Economic Order Quantity (EOQ):

$$EOQ = \sqrt{\frac{2DS}{H}}$$

- D = Demand rate (units per year)
- S = Order cost per order
- H = Holding cost per unit per year

Safety Stock:

$$\text{Safety Stock} = Z \times \sigma L$$

- Z = Z – score (based on the desired service level)
- σL = Standard deviation of demand during lead time

Reorder Point (ROP)

$$ROP = (d \times L) + \text{Safety Stock}$$

- d = Average demand per unit of time
- L = Lead time (time taken to receive an order after placing it)

3 Results And Findings:

3.1 Statistical Measures:

- Correlation between total cards printed and damages cards is 1.the perfect correlation between total cards printed and damaged indicates that the total number of cards printed increases, the damaged cards increase proportionally.
- The measures of standard deviation indicate the spread and consistency of both total printed and damaged cards across the centers. The higher variance for total cards printed suggest substantial differences in card printing volume among the centers.
- Minimum 2500 cards printed in all regions. And in some regions, it attains maximum at 150000 cards approximately.
- Minimum 5 cards damaged in each center. some centers attain max of 580 damaged cards.
- The large variance in the total cards printed and the small variance in damaged cards could indicate that some centers produce far more cards than others, but the number of damaged cards remains relatively consistent.
- In a Pareto chart (Figure 1) showing the average number of cards produced in each center, around 70 percent of the production falls within the range of 140 to 3440 cards. This means that, on average, most centers produce a maximum of around 3500 cards. There are very few centers that produce a higher number of cards. These high-producing centers may require more employees, while those producing around 3500 cards can be optimized based on their demand.

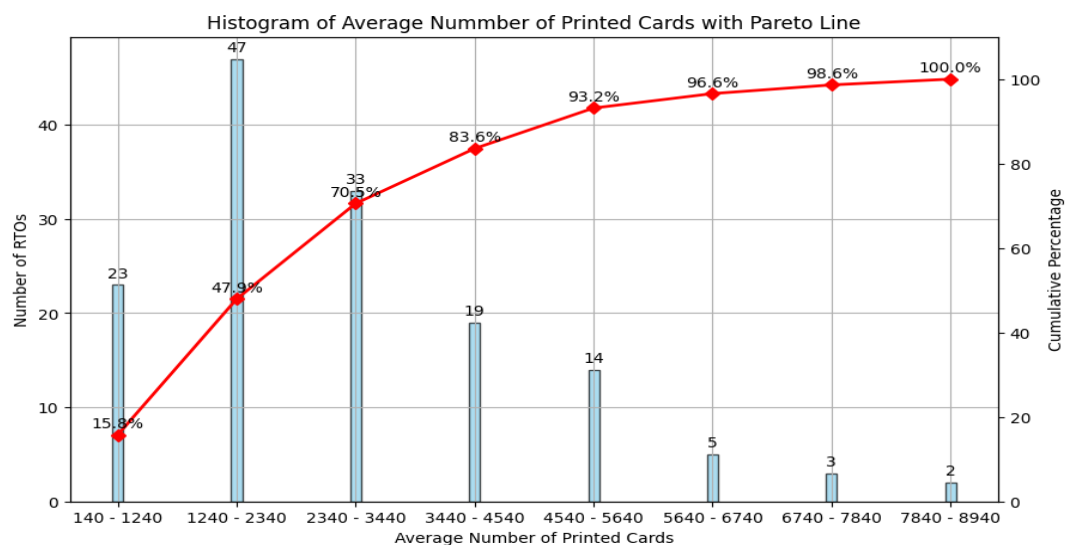


Figure 1 Pareto of Histogram Chart of Average Production

	VALUES
CORRELATION BETWEEN TOTAL CARDS PRINTED TOTAL DAMAGED CARDS	1
MAXIMUM OF TOTAL NUMBER OF PRINTED	150293
MINIMUM OF TOTAL NUMBER OF PRINTED	2526
MAXIMUM OF TOTAL NUMBER OF DAMAGED	577
MAXIMUM OF TOTAL NUMBER OF DAMAGED	5
RANGE OF TOTAL NUMBER OF CARDS PRINTED	147767
RANGE OF TOTAL NUMBER OF CARDS DAMAGE	572
VARIANCE OF THE TOTAL CARDS PRINTED	905699578
VARIANCE OF THE TOTAL CARDS DANMAGED	9510
STANDARD DEVIATION OF TOTAL PRINTED CARDS	30095
STANDARD DEVIATION OF TOTALDAMAGED CARDS	98
RANGE OF AVERAGE MONTHLY CARD PRINTED	8209

Table 2 Statistical Measures

3.2 Man Power Optimization:

3.2.1 Quantity Analysis:

Based on the pie chart (Figure 1) of the data, it is evident that 26% of the printed cards from all RTOS in Tamil Nadu are produced in Chennai. Furthermore, it is apparent that the quantity produced in Coimbatore is half of that in Chennai. Therefore, it is advisable to allocate additional employees to this region. We also need to focus less on the other regions such as Erode, Vellore, and Virudhunagar, as they produce very few cards. In addition to that, Salem, Madurai, and Tirunelveli together produce 8-9% of the total quantity.

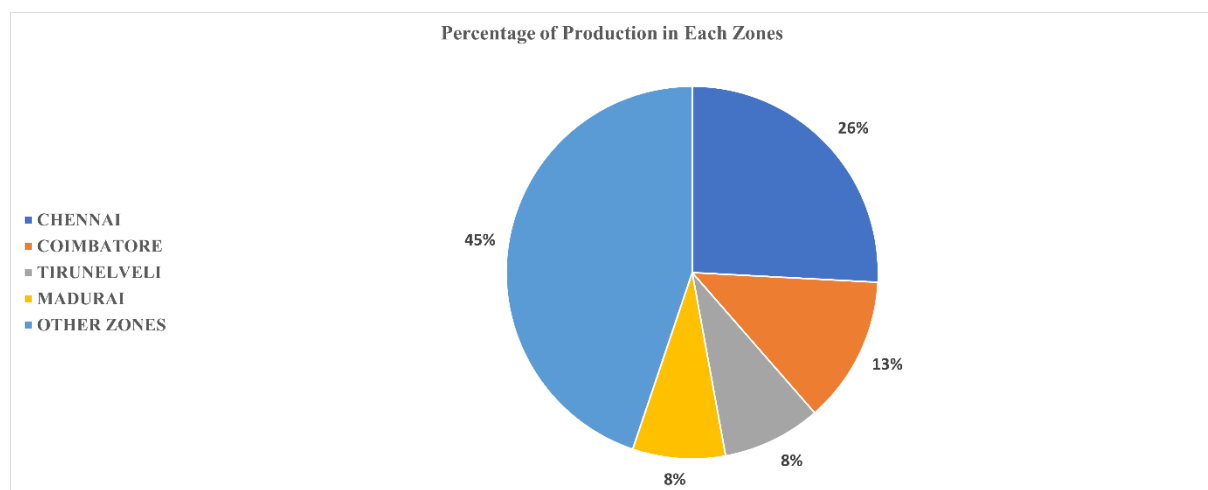


Figure 2 Pie Chart of Production Quantity

A column bar chart (Figure 2) has been prepared to visualize the quantity of smart cards printed in each region. From the chart, it's evident that Chennai has the highest number of smart cards printed, almost 1.9 million cards from January 2023 to June 2024. It's also noticeable that Virudhunagar produces a lower number of printed cards, indicating a need for fewer employees in that region.

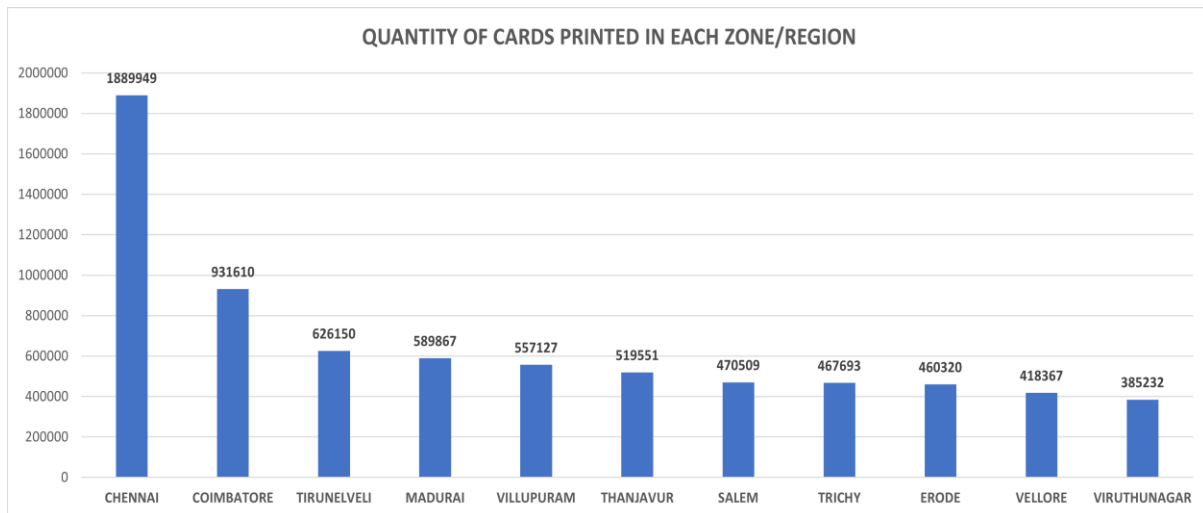


Figure 3 Production Quantity of Each Zones

After analyzing the line chart (Figure 3) for the number of cards printed in all regions from January 2023 to June 2024, it is evident that there is high demand for card printing in May and lower demand in December and January. This is due to the summer holidays in May and reduced demand for driving licenses during the heavy rains.

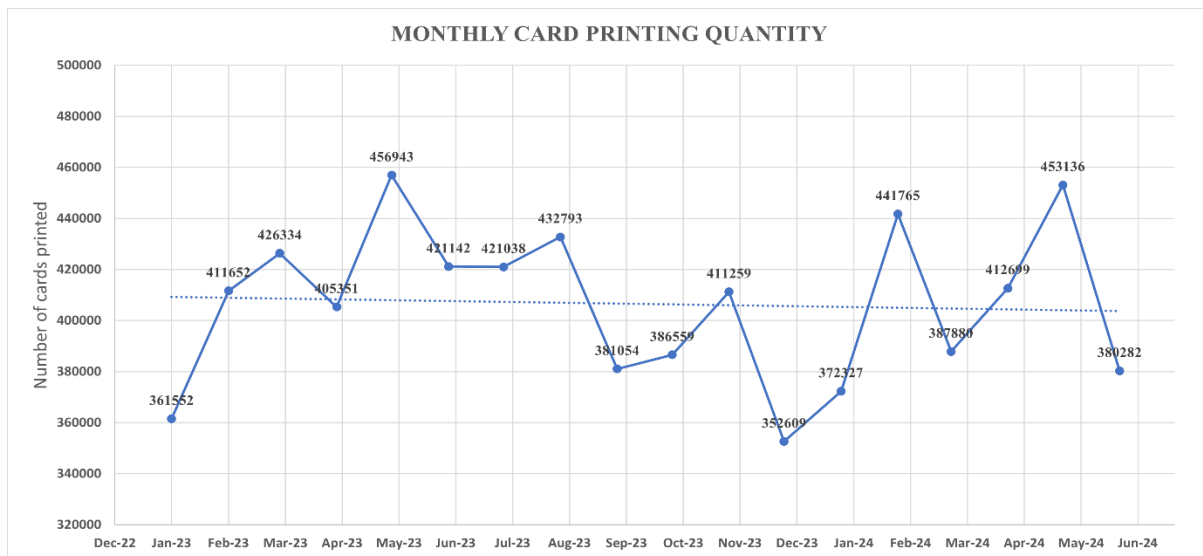


Figure 4 Line Chart for Monthly Production

The histogram (Figure 4) depicting the average number of cards printed in each RTO indicates that 2 RTO centers produce a higher quantity, with approximately 7800-8950 cards printed. Most centers process a maximum of around 3450 cards, while 38 centers produce approximately 4500 to 5600 cards.

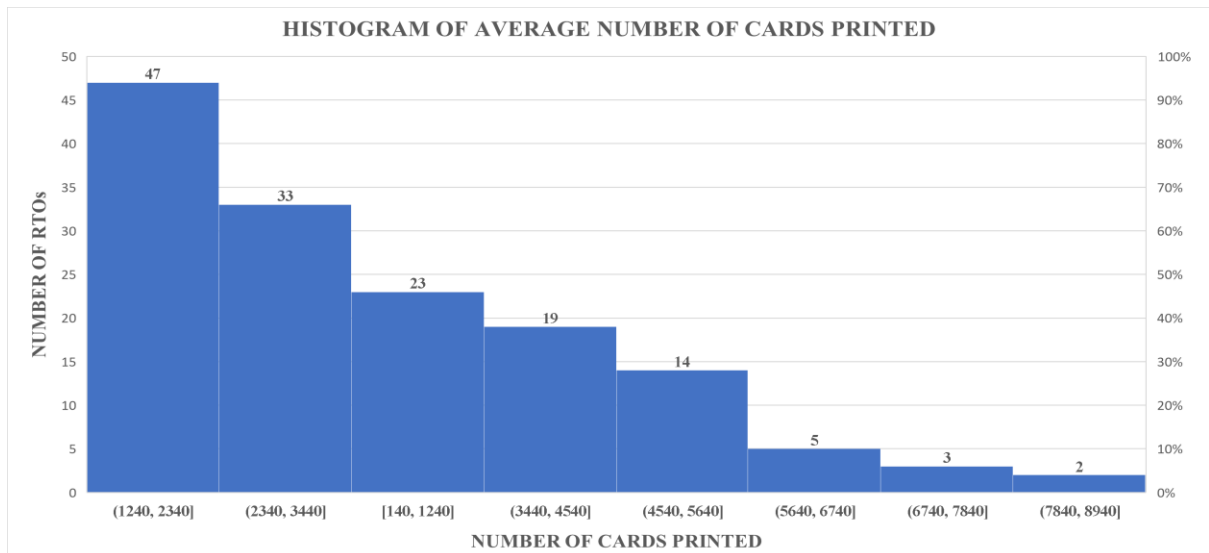


Figure 5 Histogram of Average Number of Cards Printed

3.2.2 Analysis for Optimization:

When comparing the manpower requirement value determined by the total fraction with the actual number of assigned employees, we find that they are almost similar. Therefore, the total fraction method will not be considered as a final recommendation.

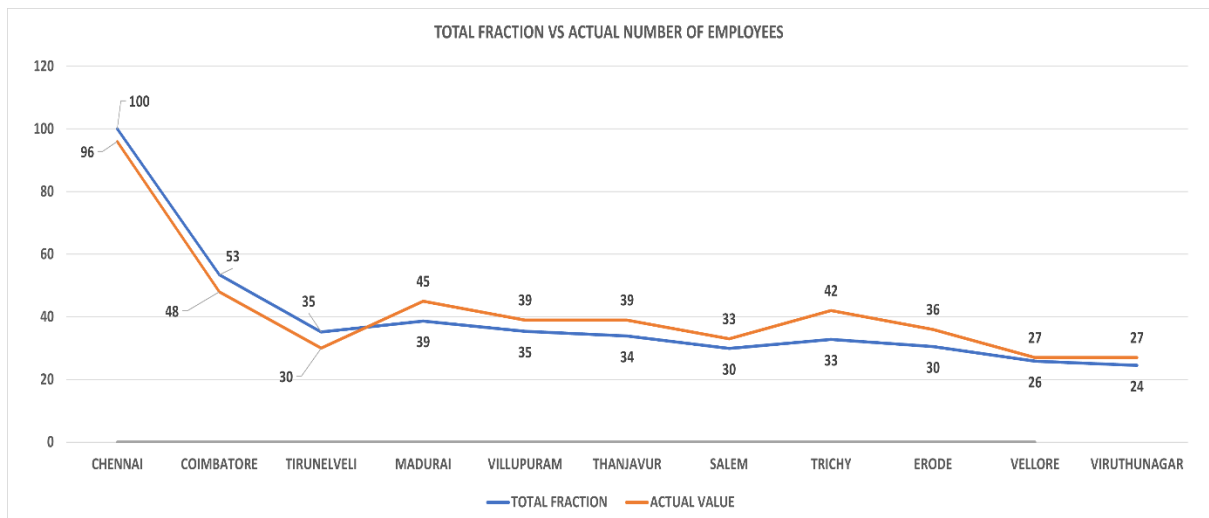


Figure 6 Comparison Between Total Fraction and Actual Employees

By creating a line chart showing the monthly productivity of a single employee from January 2023 to June 2024, we can see that the average number of cards printed is around 900. This current productivity can be used to determine the optimal manpower required for each RTO.

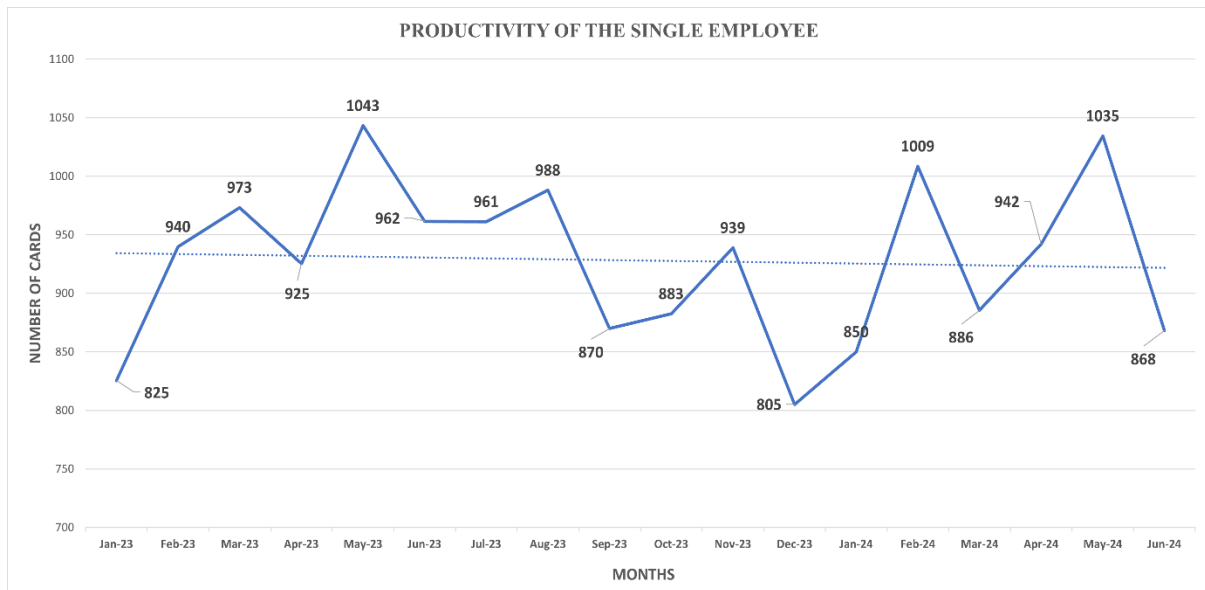


Figure 7 Line Chart for Current Productivity

After analyzing the data, the current productivity of one employee is 928 cards, with a maximum of 1000 cards that can be printed and a minimum of 800 cards printed by the single employee.

Months	Number of Cards Printed	Current Productivity
Jan-23	361552	825
Feb-23	411652	940
Mar-23	426334	973
Apr-23	405351	925
May-23	456943	1043
Jun-23	421142	962
Jul-23	421038	961
Aug-23	432793	988
Sep-23	381054	870
Oct-23	386559	883
Nov-23	411259	939
Dec-23	352609	805
Jan-24	372327	850
Feb-24	441765	1009
Mar-24	387880	886
Apr-24	412699	942
May-24	453136	1035
Jun-24	380282	868
Average		928

Table 3 Current Productivity Table

Using current productivity of the one employee man power requirement is determined. optimal values calculated table columns are given Figure,

OFFICE	ZONE	AVERAGE CARDS PRINTED/Monthly Cards Printed	ONE EMPLOYEE'S OPTIMAL PRODUCTIVITY	EXTRA CARDS NEEDS TO BE PRINTED	EXTRA MAN POWER REQUIRED	TOTAL MAN POWER REQUIRED
CHENNAI (CENTRAL)	CHENNAI (N)	3660	928	2732	3	4
CHENNAI (NORTH WEST)	CHENNAI (N)	4053	928	3125	3	4
CHENNAI (NORTH EAST)	CHENNAI (N)	4862	928	3934	4	5
CHENNAI (EAST)	CHENNAI (N)	3479	928	2551	3	4
CHENNAI (NORTH)	CHENNAI (N)	5448	928	4520	5	6
POONAMALEE	CHENNAI (N)	8350	928	7422	8	9
AMBATTUR	CHENNAI (N)	4784	928	3856	4	5
REDHILLS	CHENNAI (N)	5245	928	4317	5	6
GUMIDIPOONDI	CHENNAI (N)	991	928	63	0	1
THIRUVALLUR	CHENNAI (N)	2736	928	1808	2	3
TIRUTHANI	CHENNAI (N)	1165	928	237	0	1
CHENNAI (SOUTH EAST)	CHENNAI (S)	4817	928	3889	4	5
CHENNAI (SOUTH)	CHENNAI (S)	5787	928	4859	5	6
CHENNAI (WEST)	CHENNAI (S)	5825	928	4897	5	6
CHENNAI (SOUTH WEST)	CHENNAI (S)	6773	928	5845	6	7
TAMBARAM	CHENNAI (S)	8327	928	7399	8	9
SHOLINGANALLUR	CHENNAI (S)	6072	928	5144	6	7
CHENGALPATTU	CHENNAI (S)	3992	928	3064	3	4
THIRUKALUKUNDRAM	CHENNAI (S)	1151	928	223	0	1
MADURANTAGAM	CHENNAI (S)	1785	928	857	1	2
KANCHEEPURAM	CHENNAI (S)	3285	928	2357	3	4
MEENAMBAKKAM	CHENNAI (S)	7171	928	6243	7	8
KUNDRATHUR	CHENNAI (S)	3825	928	2897	3	4
SRIPERUMBUDUR	CHENNAI (S)	1417	928	489	1	2
VELLORE	VELLORE	4873	928	3945	4	5
GUDIYATHAM	VELLORE	1622	928	694	1	2
KRISHNAGIRI	VELLORE	4004	928	3076	3	4

Table 4 Recommended Man Power table

The analysis also indicates that the maximum number of employees to be assigned in one center is 9, with at least one employee being employed for all RTO centers. Additionally, an optimization of values is conducted through a line plot to compare actual and calculated values.

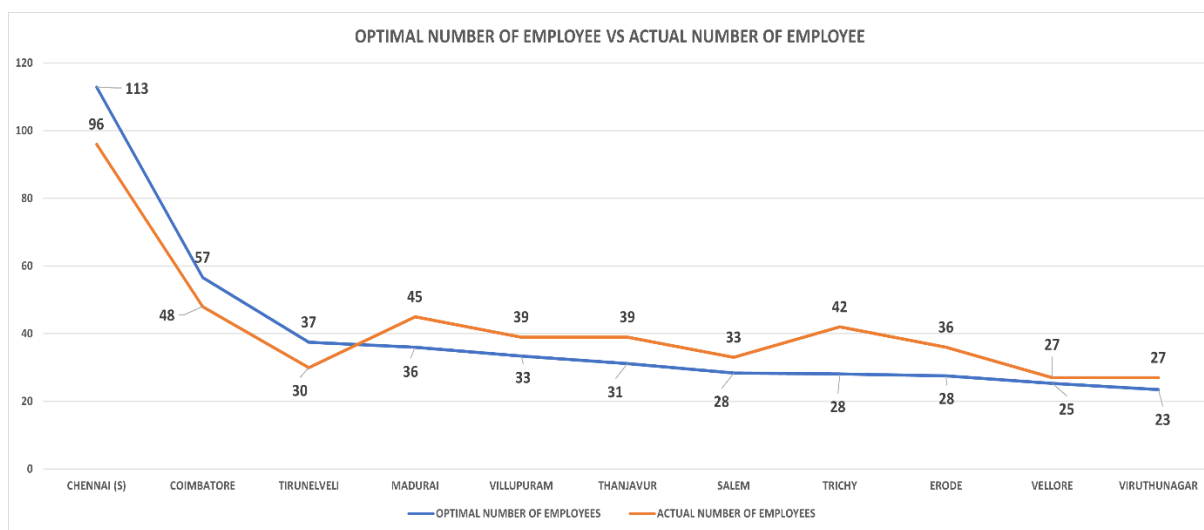


Figure 8 Comparison Between Optimal and Actual Man power

3.3 Printer Head Consumption Analysis:

The data suggests that there may be a correlation between the total number of cards printed and the total damages. Even in regions with a lower number of cards printed, such as Erode, Vellore, and Virudhunagar, there are still higher numbers of card damages. Further analysis is needed to understand the cause of these damages.

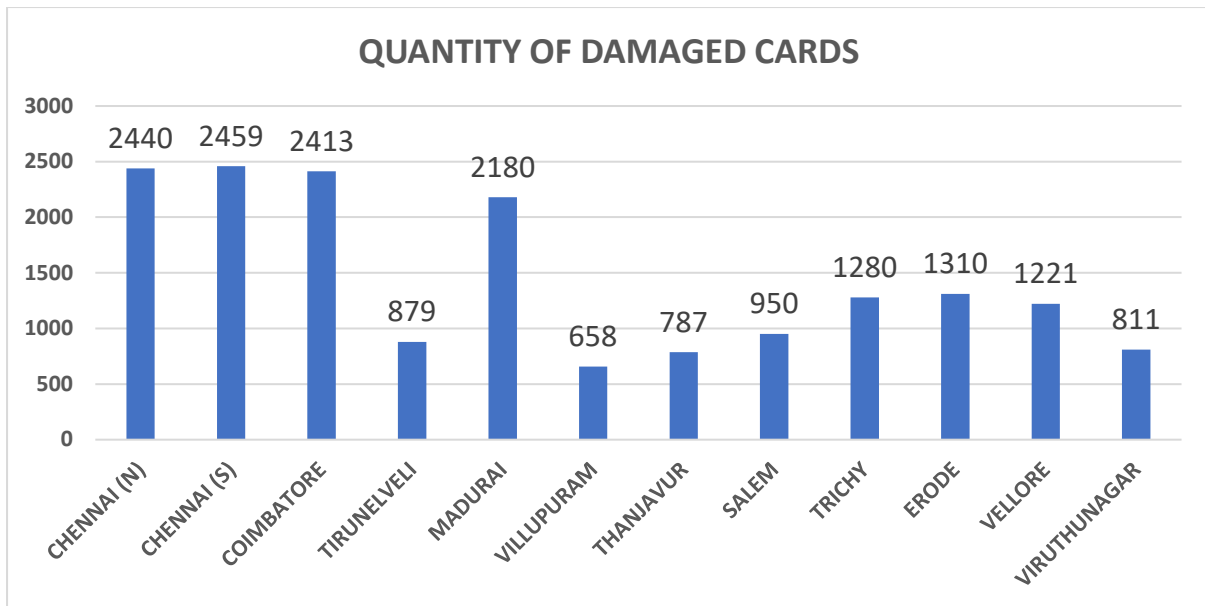


Figure 9 Column Chart of Damaged Cards

The scatter plot clearly shows a strong correlation between the total number of cards printed and the total number of cards damaged. This is likely due to a higher number of cards printed leading to a higher chance of printer head damages, which in turn results in a higher number of damaged cards. Therefore, we should determine the optimal level of cards that can be printed by a single printer in order to reduce the number of damaged cards by quickly replacing printer heads.

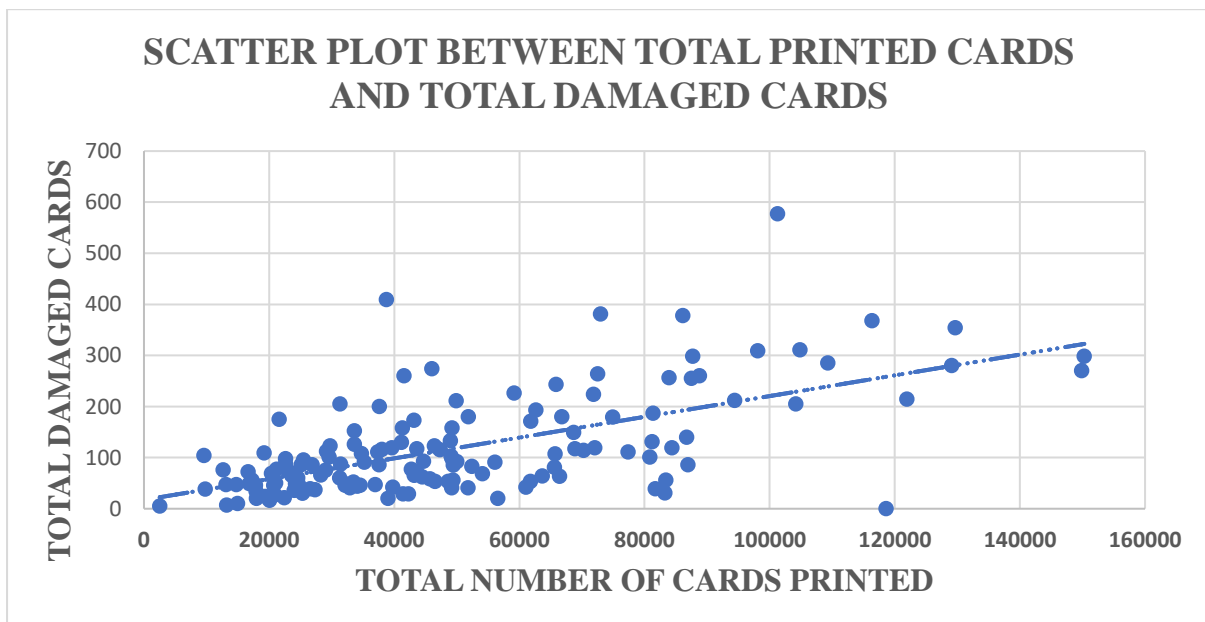


Figure 10 Scatter Plot

The heat map indicates that a higher amount of head damages occurred in the month of May. It is already known that there is higher demand for card printing in May. Demand is higher in may because in summer time college students given the summer holiday. In these months demand for printing cards will be higher. So, these months more head requirements are very high. Rainy days like December and January will be lower in demand.

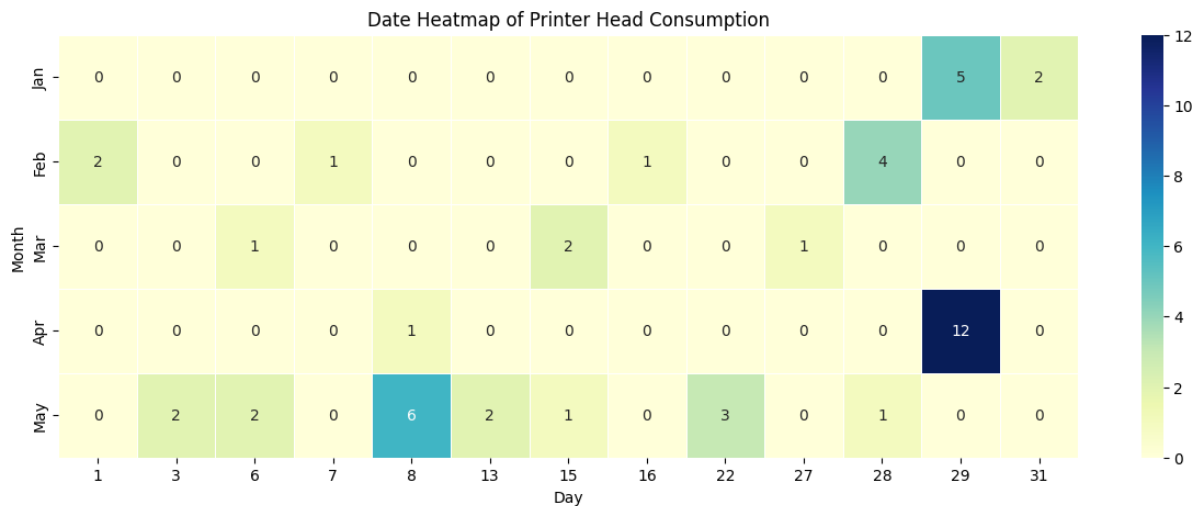


Figure 11 Heat map

The number of head consumptions in each region shows that Chennai and Tirunelveli have the highest number of head consumptions due to higher demand. However, Thanjavur also has high consumption that needs to be addressed.

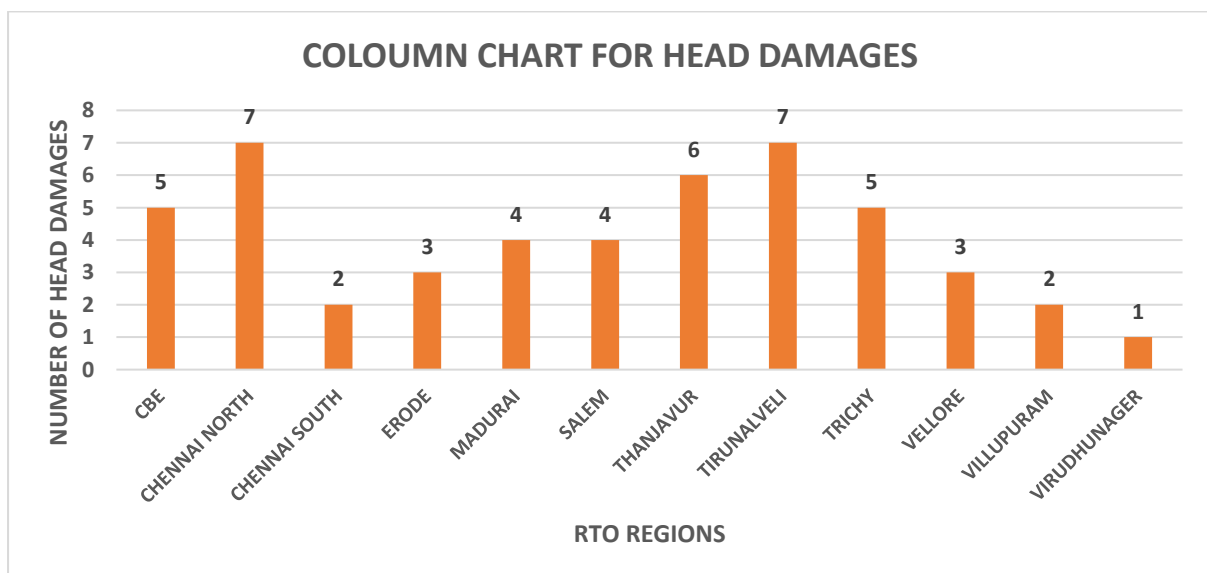


Figure 12 Number of Head Damages

To determine the number of cards that can be printed by a single head, we take the average of the total number of cards printed with respect to the frequency of head consumption. This

analysis reveals that May had the highest number of head consumptions, reflecting the higher demand for card printing and further strengthening the correlation between cards printed and head consumed. The average number of cards that can be printed is provided in the table below.

Months	Number of Cards Printed	HEAD CONSUMPTION	NUMBER OF CARDS OF A SINGLE HEAD CAN PRINT
Jan-24	372327	7	53190
Feb-24	441765	8	55221
Mar-24	387880	4	96970
Apr-24	412699	13	31746
May-24	453136	17	26655
		AVERAGE	52756

Table 5 Optimal Quantity a Single Head Can Print

The demand for printing heads in each region is determined by calculating the average number of cards printed by a single head. The results indicate that in some regions, the demand for printing heads is very low due to lower demand. In these regions, at least one printing head is assigned because it is practically required. The specific results are provided below

ZONE	MONTHLY CARD PRINTED	HEADS REQUIRED
CHENNAI (N)	44773	1
CHENNAI (S)	60225	1
COIMBATORE	51756	1
ERODE	25573	0
MADURAI	32770	1
SALEM	26139	0
THANJAVUR	28864	1
TIRUNELVELI	34786	1
TRICHY	25983	0
VELLORE	23243	0
VILLUPURAM	30952	1
VIRUTHUNAGAR	21402	0

Table 6 Required Heads

Final results with 1-week lead time:

EOQ = 3 heads

Safety Stock = 1 head

Reorder Point (ROP) = 2 heads

This implies an updated lead time of 1 week. The optimal order quantity remains the same at 3 heads, but the safety stock is slightly lower due to the reduced lead time. The reorder point also remains at 2 heads for all zones. This adjustment will help maintain the service level at 95 percent.

ZONE	MONTHLY CARD PRINTED	HEADS REQUIRED	TOTAL HEADS REQUIRED	EOQ	REORDER POINT	SAFETY STOCK
CHENNAI (N)	44773	1	2	3	2	1
CHENNAI (S)	60225	1	2	3	2	1
COIMBATORE	51756	1	2	3	2	1
ERODE	25573	0	1	3	2	1
MADURAI	32770	1	2	3	2	1
SALEM	26139	0	1	3	2	1
THANJAVUR	28864	1	2	3	2	1
TIRUNELVELI	34786	1	2	3	2	1
TRICHY	25983	0	1	3	2	1
VELLORE	23243	0	1	3	2	1
VILLUPURAM	30952	1	2	3	2	1
VIRUTHUNAGAR	21402	0	1	3	2	1

Table 7 EOQ, Safety Stock, Reorder Point

4 Results interpretation and Recommendation:

4.1 Recommendations for Manpower:

4.1.1 Recommendations for Chennai region:

- Chennai has the highest demand for smart card printing due to higher population, in these regions we need more employee that actual assigned. We have assigned 96 employees in these regions. After doing calculations and gaining insights, I recommend these regions require more employees than actually assigned. I recommend total recommended employees for these regions is 113.
- In the Poonamalee and Tambaram areas of Chennai, there is the highest demand, with 9 employees assigned to these centers. These centers have been assigned three times more employees than actually required due to the higher population. Additionally, 8 employees have been assigned to the Meenambakkam area.
- Gumidipoondi and Tirutani have the lowest demand, hence only one employee has been assigned to these areas. Other centers in these regions have been assigned between 4-6 employees.

4.1.2 Recommendations for Coimbatore region:

- Coimbatore demonstrates the second-highest demand for smartcard printing in Tamil Nadu, with 48 employees currently assigned. However, the demand surpasses

our current workforce capacity in these regions. Therefore, we propose an increase to a total of 57 employees for this region.

- For Coimbatore Central and Coimbatore North, the current allocation stands at 7-8 employees. In contrast, Dharmapuri and Gudalur exhibit lower demand for card printing, thus we suggest assigning only one employee for efficient printing.
- No adjustments are necessary for Ooty, Mettupalayam, and Sulur, as the current employee allocation adequately meets the requirements for these centers.

4.1.3 Recommendations for Tirunelveli region:

- Based on the analysis, it is evident that after Coimbatore, Tirunelveli exhibits the highest demand in comparison to other zones/regions. Currently, 30 individuals are employed for card printing in the area; however, in order to enhance operational efficiency, it is recommended to increase the workforce to 37 employees across the Tirunelveli zone/regions.
- Moreover, the Marthandam center has demonstrated the highest demand, indicating a requirement for 7 employees to effectively manage card production. Conversely, no adjustments are deemed necessary for the Valliyur and Thiruchendur centers.
- In addition, it is recommended that the Tirunelveli, Nagercoil, and Tenkasi centers employ 4-5 individuals, while other centers may require 2-4 employees to ensure smooth operations.

4.1.4 Recommendations for Tirunelveli region:

- Despite being a larger city, the demand for printed cards in Madurai is lower than in the Tirunelveli region. Therefore, there are factors other than population that affect this demand.
- Currently, 45 employees are assigned to these regions, but only 36 employees are actually required to efficiently operate the centers in Madurai.
- In Theni and Uthamapalayam, no changes are needed as we already have the required number of employees.
- In Natham, Usilampatti, Vadaipatti, Melur, and Vendasandur, only one employee is sufficient to handle card printing due to the lower demand. For Madurai Central and Dindigul, it is recommended to have 4-5 employees to complete the task.

4.1.5 Recommendations for Villupuram and Thanjavur regions:

- In both the Villupuram and Thanjavur regions, there are currently 39 employees assigned. Both regions have lower demand for smart card printing, therefore, a lower number of employees is sufficient to meet the demand.
- In the Villupuram zone, the Tiruvannamalai center requires 5 employees, and the Kalla kurichi center requires 4 employees to meet the demand. Villupuram and Cuddalore require no changes; 3 employees are sufficient to complete the task. In other centers in this region, 2 employees are adequate to meet the demand.
- In the Thanjavur and Kumbakonam centers, it is recommended to assign 5 employees. No changes are required in the Mayiladuthurai and Nagapattinam centers. Sirkali, Thiruthuraipoondi, Alangudi, Iruppur, and Aranthangi require only one employee to complete the task. In other centers, 2 employees are required to meet the demand and complete the task efficiently.

4.1.6 Recommendations for Salem region:

- In the Salem zone, there are currently 33 employees assigned, but we only require 28 employees to fulfill the demand for printing the necessary cards. Despite Salem being a large city, the demand for printing cards is lower than expected.
- No changes are necessary in the Dharma Bhuri, Omalur, Sanga Giri, Salem East, and Attur centers. However, it is recommended to assign 5 employees to Salem West to meet the demand. For the other centers in the Salem zone, 1-2 employees are recommended.

4.1.7 Recommendations for Trichy region:

- In the Trichy region, there are currently 42 employees, but the demand for card printing is lower than the current workforce. It is suggested that 28 employees would be sufficient to operate the center efficiently.
- Trichy West currently has 5 employees due to higher demand, while no changes are necessary in Preambular, Ariyalur, and Srirangam. Four centers in the Trichy region can effectively handle card printing with just one employee, while the remaining centers would benefit from having two employees.

4.1.8 Recommendations for Erode region:

- In Erode, a total of 36 employees have been assigned. Due to lower-than-expected demand, we are reducing the number of employees assigned in these zones to a total of 28.
- Currently, 4 employees are assigned to Erode East centers, and no changes are required at Namakkal centers. For more insights on these zones, please refer to the Excel file mentioned below.

4.1.9 Recommendations for Vellore and Virudhunagar regions:

- For the initial phase in Vellore and Virudhunagar, the company has hired 27 workers. However, it is recommended to employ 23-25 employees to meet the demand.
- In the Vellore zone, it is recommended to hire 5 members for the Hosur and Vellore centers, while one employee is sufficient for Ambur and Tirupattur. For the other centers in the Vellore region, it is recommended to have 2-3 employees.
- In the Virudhunagar Sivagangai center, it is recommended to employ 3 workers, while no changes are required in Ramanathapuram. One employee is sufficient for Aruppukottai and Ramanagaram, and 2 employees are assigned to the other centers.

4.2 Recommendations for Total Head Consumption:

- For all regions, it is recommended to maintain an optimal quantity of 3 printer heads. Additionally, in the month of May, it is advisable to procure an extra printer head due to the high demand, particularly in the Chennai region/zone.
- After consulting with the manager, it was determined that the lead time is approximately seven to fourteen days. Assuming a 14-day lead time, it is suggested to reorder when the stock reaches 2 printer heads. Moreover, it is advisable to maintain a safety stock of one printer head for emergency situations.
- The company should provide comprehensive training to its employees, especially in rural areas. Despite lower demand, there is a higher incidence of damaged cards and printer head consumption in certain regions. Employees in Tirunelveli should receive training on printer usage and maintenance.
- It is important to note that continuous use of the printer head can lead to damage. Proper rest and usage are necessary to maximize efficiency.
- A tutorial video demonstrating the proper method for cleaning the printer head has been provided. I recommend that the manager share this video with all employees to

minimize errors. The video is presented in Tamil to ensure that regional workers can comprehend the instructions. You can access the tutorial video through the following link: [Cleaning Tutorial](#)

5 Conclusion:

In this report, we have discussed the recommendations for manpower requirements and provided a brief explanation of the calculated head requirements.

It is advisable to increase the workforce in the months of May and June, as the demand is expected to be higher during the summer. It is important to ensure that the head requirements are met during these months.

Chennai has the highest demand for smart card printing compared to other zones. Therefore, it is recommended to hire skilled labor in these regions. Additionally, maintaining and cleaning the printer can help reduce the number of damaged cards and increase production.

The results and recommendations have been communicated to the company manager and the senior business analyst.

ANALYSIS SHEET: [Analysis File](#)