Optimizing and Smart Solutions for Apparel Transportation Problem

PROJECT REPORT

GROUP 8

CONTENT

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to everyone who supported and guided us throughout this project. Their invaluable guidance, support, and contributions have been instrumental in making this endeavor possible.

First and foremost, We extend our heartfelt thanks to our esteemed instructor and Head of the Department, Dr. Niluka Rodrigo. Her leadership, encouragement, and dedication to fostering a supportive learning environment were instrumental in driving this project forward and greatly enriched my understanding of route optimization in the apparel industry.

We are also immensely thankful to our project supervisor, Dr. Mangalagama Dewasurendra, for their invaluable insights, guidance, and expertise. Their support was a constant source of motivation and helped us navigate the complexities of data analysis and model optimization.

Our appreciation extends to Prof. Wasantha Daundasekara, Dr. Mahasen Dehideniya, Dr. Chaturanga Mudalige and other lecturers. Their constructive suggestions and feedback shaped our approach, providing new perspectives and ideas that enhanced the overall quality of this project.

Finally, We are grateful for the tools and resources, including Python and Excel, which facilitated the analysis and modeling processes. We also acknowledge the support from online communities that offered valuable tutorials and resources, helping us expand our technical skills.

Thank you to everyone who has been part of this journey. Your encouragement, guidance, and knowledge-sharing have been invaluable in completing this project successfully.

GROUP 8 - MEMBERS

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ABSTRACT

This project addresses the optimization of transportation routes within the apparel industry to minimize delivery costs and streamline logistical operations. A linear programming model was used to identify the most cost-effective routes between distribution centers and retail outlets. The analysis focused solely on optimizing route data, with solutions verified using manual calculations and Excel Solver.

In addition to route optimization, a data entry and visualization system was developed using HTML and CSS, providing a user-friendly interface for recording and tracking route information. An Excel dashboard was also created to facilitate real-time updates and to support decision-making by displaying cost breakdowns and route performance metrics.

This project demonstrates a cost-effective approach to solving transportation challenges in the apparel sector, providing a replicable model that can adapt to varying logistical needs. The optimized routing model, combined with the data entry system and visualization dashboard, offers a comprehensive solution that enables strategic decision-making and contributes to reduced operational costs.

1.INTRODUCTION

Company Overview

Parkland, a distinguished apparel brand based in Alawathugoda, Kandy, is renowned for its premium-quality shirts, including formal, casual, and party wear. With island wide operations, the company serves a diverse customer base, ensuring style, comfort, and quality in every product. Parkland's dedication to excellence has established its reputation as a trusted name in Sri Lanka's apparel industry.

As a forward-thinking company, Parkland focuses on efficiency and innovation in its logistics and supply chain processes. By addressing the unique challenges of island wide transportation and demand forecasting, the company aims to streamline its operations, reduce costs, and deliver superior value to customers across the nation.

Address : 1556/2, Kandy road, Alawatugoda , Sri Lanka, 20140

Vision : "To lead the future of fashion by creating stylish, sustainable clothing that empowers everyone to express their individuality while protecting the planet."

Mission :"To deliver high-quality, eco-friendly apparel that combines the latest trends with ethical practices, making fashion accessible, responsible, and uniquely personal for all."

2. LITERATER REVIEW

Efficient transportation management plays a pivotal role in ensuring the success of supply chain operations, particularly in the apparel industry, where product delivery directly impacts customer satisfaction and operational costs. This section explores relevant research and methodologies applicable to optimizing transportation and integrating dashboard systems for decision-making.

Transportation Challenges in the Apparel Industry

The apparel industry, characterized by rapid fashion cycles and diverse product offerings, faces unique transportation challenges. Studies by Fernie and Sparks (2004) emphasize the importance of optimizing transportation routes to reduce lead times and costs. Similarly, Christopher (2016) highlights the critical role of logistics in managing demand variability and ensuring seamless distribution across multiple locations.
The geographical distribution of retail shops, as in the case of Parkland's island wide operations, further complicates transportation planning. Research by Choi and Cheng (2015) demonstrates that incorporating demand clustering and route optimization significantly improves efficiency in such scenarios.

Linear Programming for Transportation Optimization

Linear programming (LP) has long been a cornerstone of transportation optimization. The transportation problem, a specific application of LP, involves minimizing transportation costs while satisfying supply and demand constraints (Dantzig, 1949). In the context of Parkland, applying LP models helps determine the most cost-effective routes for delivering shirts from the manufacturing facility in Alawathugoda to retail outlets across the island.

Recent advancements, such as the integration of LP with Python and Excel tools, have made these models more accessible. For instance, Verma et al. (2020) demonstrated the effectiveness of Python in solving transportation problems through its ability to handle large datasets and automate repetitive tasks.

Data Visualization and Dashboard Systems

Dashboards have emerged as powerful tools for simplifying data interpretation and enhancing decision-making. According to Kutz (2016), Excel dashboards offer an intuitive platform for visualizing transportation metrics, such as fuel costs, delivery times, and vehicle utilization rates. Small to medium-sized enterprises (SMEs), like Parkland, benefit significantly from the affordability and flexibility of Excel-based solutions.

The use of advanced Excel functionalities, including pivot tables, VLOOKUP, and dynamic charts, enables managers to monitor performance and identify inefficiencies in real-time. Research by Al-Harbi et al. (2018) highlights the importance of such tools in reducing manual errors and providing actionable insights.

Addressing Island wide Transportation Needs

The unique geographic challenges of operating on an island demand innovative transportation strategies. Studies by Jayasooriya and Fernando (2019) emphasize the importance of route optimization in Sri Lankan logistics. By combining manual techniques with computational tools, companies can effectively address cost fluctuations, traffic patterns, and vehicle maintenance schedules.

3. METHODOLOGY

Problem Statement

- **No Data Entry System:**
  - Parkland operates across the island but does not have a centralized data entry system to capture shop-wise demand data. This limitation makes it difficult to track, manage, and analyze demand trends, resulting in inefficiencies in decision-making and operations.
- **Uninformed Demand Forecasting:**
  - The company heavily relies on manual inputs from sales representatives to determine the demand for shirts at each shop. This reactive approach to demand forecasting creates challenges in planning inventory, production, and distribution, often leading to missed opportunities or unnecessary expenses.
- **Supply-Demand Imbalance:**
  - Without accurate demand predictions, Parkland faces difficulties in matching supply with demand. Increasing product supply without a clear understanding of shop-specific needs results in either overstocking, which ties up capital, or shortages, which affect customer satisfaction and sales.
- **Cost Inefficiency:**
  - Inefficient transportation planning due to the lack of optimized logistics leads to higher operational costs and delayed deliveries. This not only impacts the company's profitability but also its ability to meet customer expectations effectively.

Focus Areas

1. **Developing a Data Entry System:**
    - Design and implement a centralized digital platform where shop-wise demand data can be recorded, stored, and accessed efficiently.
    - Ensure the system allows easy data entry, error validation, and integration with existing processes.
    - Incorporate features for historical data retrieval and updates to enable better tracking and comparison over time.
2. **Demand Forecasting and Optimization:**
    - Build predictive models to analyze past sales trends and forecast future demand for each shop.
    - Use optimization techniques to allocate resources effectively and meet shop-specific demand while minimizing waste.
    - Develop dynamic tools that can adjust forecasts based on real-time updates or changing market conditions.
3. **Interactive Tools for Sales Representatives:**
    - Develop an application tailored for sales representatives to enter shop-wise demand data on-the-go.
    - Ensure the app integrates seamlessly with the central data system, updating dashboards and models in real-time.
    - Include features like demand visualization, notifications for missing entries, and access to historical data for informed decision-making.
4. **Data-Driven Decision Making:**
    - Leverage historical sales and transportation data to identify trends, seasonality, and potential growth areas.
    - Use analytics to provide actionable insights, such as top-performing routes, shops with high demand variability, or cost-saving opportunities.

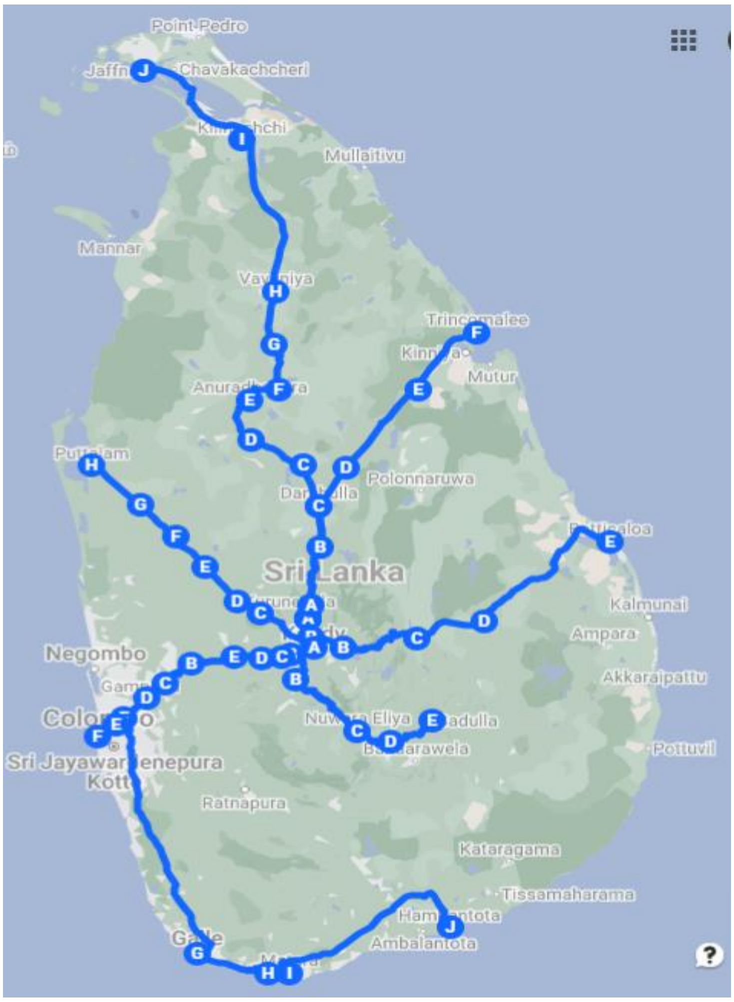
- Build dashboards and visualizations to support management in strategic decision-making and performance monitoring.

Main Components

- Routes
- Shirt Demand of Shops
- Delivery Vehicle
- Logistic Staff

DATA COLLECTION

➢ Routes and Shops



Colombo Route

City	Shops
Warakapola(X41)	Divine Factory Outlet Asb Fashion
Nittambuwa(X42)	Nihal Fashion Thilakawardhana
Yakkala(X43)	Louies Ruvini Fashion Bimak Fashion
Kiribathgoda(X44)	Thilakawardana Spring & Summer Kandy Osaka Ruth Styles
Colombo(X45)	House Of Fashion The Fashion Store Nolimit Shriyani
Kottawa(X46)	Prasad The Fashion Square Ash Clothing
Maharagama(X47)	Coolplanet Nils Stoke Rich Look Nolimit Cib Fashion Bug
Piliyandala(X48)	Cib Inter Fashion Mostra
Malabe(X49)	Coolplanet Supul Collection Sela Fashion

Badulla Route

City	Shops
Kandy(X51)	Thilakawardhana Shriyani Dresspoint Fashion Bug Cib Nolimit
Gampola(X52)	Cib Nadiya's
Nuwaraelliya(X53)	Colorz Infinity Fashion
Welimada(X54)	Jayamali Fashion New Sattar Stores Nilum Fashion
Baddulla(X55)	Rlg Fashion House Of Island Yonah Step

Trincomalee Route

City	Shops
Matale(X71)	Nadiya's Textile Cib Choice Park Shriyani
Naula(X72)	Herath Texlile Ar Fasion
Dambulla(X73)	High Royal Clothing Sanilka Textile Cib
Habarana(X74)	Beard Man Sl Collection Max Fashion
Kanthale(X75)	Pathirana Textile
Trincomalee(X76)	Lionel Textiles

	Simcity Kinniya Nafeek Textile

Puttalam Route

City	Shops
Katugastota(X21)	Choice Park Fashion Bug City Max
Mawatagama(X22)	Y Fashion Elite Fashion
Kurunagala(X23)	Shriyani Cib Fashion Bug Norlimit Kandy
Wariyapola(X24)	Jaya Sri Fashion
Nikaweratiya(X25)	Buddima Dresspoint Fashion House Ritz Clothing
Anamaduwa(X26)	Munasighna Fasion World Hasidu Fashion
Puththalama(X27)	Fashion Way Clothing Store Fashion Direct Ahsan Tex

Hambantota Route

City	Shops
Pilimathalawa(X31)	Fashion Park
Kadugannawe(X32)	Sanjeewa Stores And Dress Point Kadurata T Shirt
Mawanella(X33)	Bombay Dresspoint Sahara Dress Point
Kegalle(X34)	Shriyani Dresspoint

	Mona Clothing Store Nolimit
Kadawata(X35)	Kandy Men's Collection Fashion House
Galle(X36)	The Factory Outlet The Fashion Store Hemara Rich Look
Ahangama(X37)	Slow Days Sri Lanka

Batticalo Route

City	Shops
Digana (X11)	Family Fashion City Point
Mahiyanganaya(X12)	Primark Men'z Gihara Fashion
Padiyathalawa(X13)	Thennakoon Textiles
Mahaoya(X14)	Neen Fashion Hub Mr.Legends
Batticalo(X15)	Meemas City Choice Zaraa Men City Gents

Jaffana Route

City	Shops
Dambulla(X61)	Cib Top Choice Cheap Center
Kekirawa(X62)	Choice Park Nirmani Dress Point
Thalawa(X63)	Fashion Store

Anuradhapura(X64)	Cib Diliganz Fashion Nirmani Fashion
Mihinthale(X65)	Signature Showroom Sugath Tex U Fashion
Madawachchiya(X66)	Wije Fasion House Dib Dresspoint
Wawniyawa(X67)	Rock Model Mr Dude Men's Wears
Kilinochchiya(X68)	Fashion Connection Kumaran Textile Ishara New Dressmart
Jaffna(X69)	Trendy Jaffna Abi Fashion World Kings Of Fashion

➢ Vehicle Data

- There are 8 lorries
- Each Lorry has a capacity of 7 TONS
- A lorry can carry maximum of 7000 T-Shirts
- Fuel efficiency is varying in between 5,6,7 Kilometers per Litre
- Annual cost for insurance is Rs.35000 for each lorry
- Maintenance Cost-
    - In calculating maintenance cost we consider Front wheel which should be replaced after 20000Km is cost Rs.24500
    - Back wheel should replace after 40000Km and its cost Rs35000
    - There is Other maintenance cost of Rs.60000 for every 40000Kms

➢ Logistic Staff

- There are 8 drivers and 8 supporters for each driver
- Each Driver Gets a wage of Rs.63000 and work 216 hours per month
- A Supporter Gets a wage of Rs.37500 and work 216 hours per month

DATA ANALYSIS

Fuel Cost Calculation

Batticalo								
	shops	**distance**		fuel(Liter)	Price(LKR)		**time**	
Digana (x11)	Family fashion	27km	27	4.909090909	1745.181818	1h	60	
	City point						40	
mahiyanganaya(x12)	Primark	61km	61	11.09090909	3942.818182	1h 40min	100	
	MEN'Z						70	
	Gihara Fashion							
padiyathalawa(x13)	Thennakoon Textiles	33km	33	6	2133	40min	40	
							20	
mahaoya(x14)	NEEN Fashion Hub	22km	22	4	1422	30min	30	
	Mr.Legends						30	
batticalo(x15)	Meemas	58km	58	10.54545455	3748.909091	1h 5min	65	
	City Choice						120	
	Zaraa Men							
	CITY GENTS							
			201	36.54545455	12991.90909		575	
							9.583333333	
							295	
							4.916666667	
						total time	14.5	
	fuel Price(LKR)	355.5						
	Delivered	201						
	Returned	201						
	Average Fuel Effiency	5.5						

Fuel 1-liter price

2023/01/01	2023/03/23	450
2023/03/23	2023/05/03	325
2023/05/03	2023/08/22	310
2023/08/22	2023/10/06	341
2023/10/06	2023/11/04	351
2023/11/04	2023/12/12	356
		355.5

Lorry ID	Fuel Effiency					
V2	6	1		2	1	4
V6	5	1	2		1	4
						8

1. Calculate Total Fuel Cost for each route

No of fuel liters = Distance / Average Fuel efficiency

Fuel cost = No of fuel liters * Fuel 1-liter price

Total Fuel Cost for the route = Sum (From one city to another in same route)

2. Calculate Total Fuel Cost for each route (for 3 months)

Total Fuel Cost (3 Month)	51967.63636					
per Shirt		6.455607002	7.046459168	7.800020467	6.396016783	6.924525855

Total Fuel Cost for each route = Total Fuel Cost for the route * 2 * 2

For one quarter there are 2 vehicles used here.

From company to destination and again return to the company.

Total Fuel Cost for each route per shirt = Total Fuel Cost for each 3 months in one year

3. Calculate Average Fuel Cost per shirt in each route

		3 month Average Data							
	sum of Shirts	83061.77083							
Route Name	Route ID	Total Distance(KM)	Total time(h)	Max supply	Fuel Cost	Maintain cost	Wages cost	Total cost	Fuel Cost (per Shirts)
Batticalo	R1	201	14.5	14000	51967.63636	4582.8	40076.38889	96626.82525	6.924525855
Puththalama	R2	145	13.91666667	21000	54579.70588	4959	57696.18056	117234.8864	5.342550252
Hambanthota	R3	399	26.25	21000	148011.6522	13645.8	108828.125	270485.5772	10.27932065

Maintain Cost Calculation

1. Calculate Vehicle Maintenance Cost per KM

We can calculate vehicle maintenance cost for one vehicle using given data.

For V2 = (Total cost to change tires for 40000 KM + Other Costs)

2. Calculate Vehicle Maintenance Cost for each route

Maintenance Cost for one vehicle = Total Distance of the root * 2 * No of times vehicle used in 3 months * Maintain Cost for one vehicle (per KM)

3. Calculate Total Vehicle Maintenance Cost for each route (for 3 months)

Maintain cost						
Lorry ID	Maintain Cost (per KM)					
V2	5.7	2291.4	0	4582.8	2291.4	
V6	5.7	2291.4	4582.8	0	2291.4	
Maintain cost (3 month)		4582.8				
per Shirt		0.5692919255	0.6213966102	0.6878499062	0.5640369231	0.6106438412

Vehicle maintenance Cost for the route = Sum (Maintenance cost of each vehicle)

Total Maintain Cost for each route per shirt = Total Maintain Cost for each 3 months in one year

4. Calculate Average Vehicle Maintenance Cost per shirt in each route

3 month Average Data

sum of Shirts 83061.77083

Route Name	Route ID	Total Distance(KM	Total time(h)	Max supply	Fuel Cost	Maintain cost	Wages cost	Total cost	Fuel Cost (per Shirts)	Maintain cost (per Shirts)
Batticalo	R1	201	14.5	14000	51967.63636	4582.8	40076.38889	96626.82525	6.924525855	0.6106438412
Puththalama	R2	145	13.91666667	21000	54579.70588	4959	57696.18056	117234.8864	5.342550252	0.4854131453
Hambanthota	R3	399	26.25	21000	148011.6522	13645.8	108828.125	270485.5772	10.27932065	0.9476926423

Wages Cost Calculation

1. Calculate Total Driver Wages Cost per hour

We can calculate total driver wages cost using given data.

Total Driver Wages Cost = Sum (Monthly wages of each driver) / Sum (Working time of each driver per month)

2. Calculate Total Supporter Wages Cost per hour

Total Supporter Wages Cost = Sum (Monthly wages of each supporter) / Sum (Working time of each supporter per month)

3. Calculate Total Driver and Supporter Wages Cost per hour

Total Driver and Supporter Wages Cost = Total Driver Wages Cost + Total Supporter Wages Cost

4. Calculate Wages Cost for 3 months

Wages cost						
Wages cost (3 month)	40076.38889					
per shirt		4.978433402	5.434086629	6.015217844	4.932478632	5.340054127

5. Calculate Average Wages Cost per shirt in each route

3 month Average Data

	sum of Shirts	83061.77083									
Route Name	Route ID	Total Distance(KM	Total time(h)	Max supply	Fuel Cost	Maintain cost	Wages cost	Total cost	Fuel Cost (per Shirts)	Maintain cost (per Shirts)	Wages cost (per Shirts)
Batticalo	R1	201	14.5	14000	51967.63636	4582.8	40076.38889	96626.82525	6.924525855	0.6106438412	5.340054127
Puththalama	R2	145	13.91666667	21000	54579.70588	4959	57696.18056	117234.8864	5.342550252	0.4854131453	5.647607274
Hambanthota	R3	399	26.25	21000	148011.6522	13645.8	108828.125	270485.5772	10.27932065	0.9476926423	7.558048142

Total Transport Cost per Shirt

Fuel Cost (per Shirts)	Maintain cost (per Shirts)	Wages cost (per Shirts)	Total cost(per Shirts)	Shops
6.924525855	0.6106438412	5.340054127	12.87522382	x11
				x12
				x13
				x14
				x15
5.342550252	0.4854131453	5.647607274	11.47557067	x21
				x22
				x23
				x24
				x25
				x26
				x27
10.27932065	0.9476926423	7.558048142	18.78506144	x31
				x32
				x33
				x34
				x35
				x36
				x37
				x38
				x39
				x310
				x311
				x312

Total transport cost = fuel cost + maintenance cost + wages cost

MODEL FORMULATION

Linear Programming (LP) Model

- Minimize z $= \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij}$
- Subject to,
  - $\sum_{i=1}^{m} x_{ij} \leq s_i \quad for \;\; i = 1, 2, \dots, n \;\; (supply\ constraints)$
  - $\sum_{j=1}^{n} x_{ij} \geq d_i \quad for \;\; j = 1, 2, \dots, m \;\; (demand\ constraints)$
  - $x_{ij} \;\; \geq 0 \quad for \;\; i = 1, 2, \dots, n \;\; and \;\; j = 1, 2, \dots, m$

  - c_{ij} - cost per unit
  - x_{ij}- number of units

Solution Methods

- Simplex Method

Model Division Based on Shirt Count

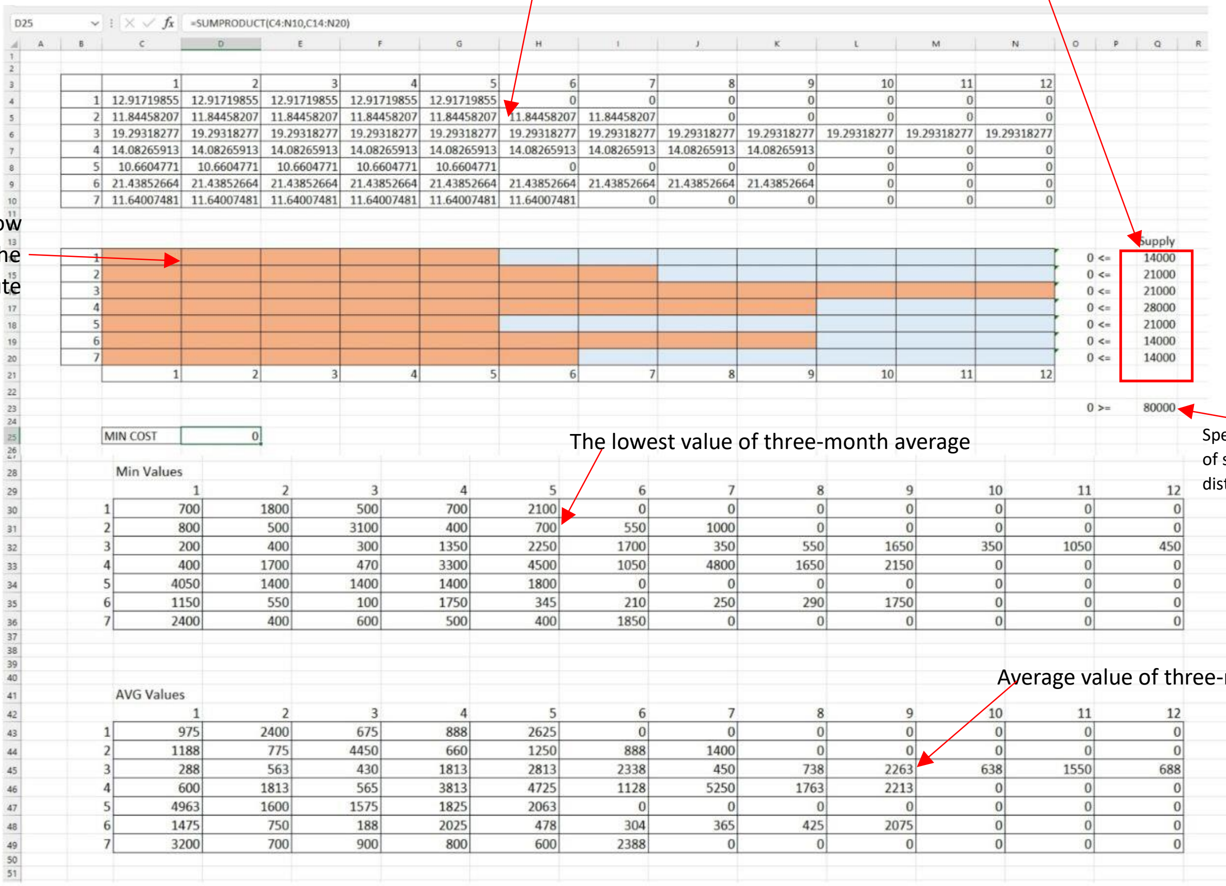
We propose a dual-model approach based on the average shirt count of 83,000 units. For production levels below this threshold, the **first model** will be used, emphasizing continuous adjustments to optimize efficiency. For levels above 83,000, the **second model** will address discrete production changes, better capturing stepwise scaling strategies. This approach ensures tailored solutions for varying production demands.

Model 1

Transformation cost per shirt each route

Max supply each route

Solution for How do distribute the shirts each route



D25 =SUMPRODUCT(C4:N10,C14:N20)

	1	2	3	4	5	6	7	8	9	10	11	12
1	12.91719855	12.91719855	12.91719855	12.91719855	12.91719855	0	0	0	0	0	0	0
2	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	0	0	0	0	0
3	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277
4	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	0	0	0
5	10.6604771	10.6604771	10.6604771	10.6604771	10.6604771	0	0	0	0	0	0	0
6	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	0	0	0
7	11.64007481	11.64007481	11.64007481	11.64007481	11.64007481	11.64007481	0	0	0	0	0	0

		Supply
1	0 <=	14000
2	0 <=	21000
3	0 <=	21000
4	0 <=	28000
5	0 <=	21000
6	0 <=	14000
7	0 <=	14000
	0 >=	80000

MIN COST 0

Specified number of shirts to be distributed

The lowest value of three-month average

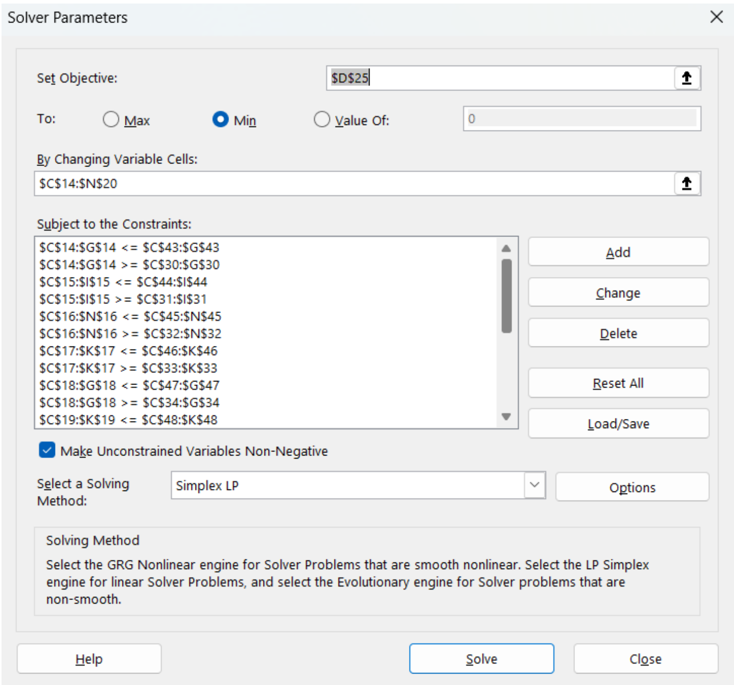
Min Values

	1	2	3	4	5	6	7	8	9	10	11	12
1	700	1800	500	700	2100	0	0	0	0	0	0	0
2	800	500	3100	400	700	550	1000	0	0	0	0	0
3	200	400	300	1350	2250	1700	350	550	1650	350	1050	450
4	400	1700	470	3300	4500	1050	4800	1650	2150	0	0	0
5	4050	1400	1400	1400	1800	0	0	0	0	0	0	0
6	1150	550	100	1750	345	210	250	290	1750	0	0	0
7	2400	400	600	500	400	1850	0	0	0	0	0	0

Average value of three-month shirts

AVG Values

	1	2	3	4	5	6	7	8	9	10	11	12
1	975	2400	675	888	2625	0	0	0	0	0	0	0
2	1188	775	4450	660	1250	888	1400	0	0	0	0	0
3	288	563	430	1813	2813	2338	450	738	2263	638	1550	688
4	600	1813	565	3813	4725	1128	5250	1763	2213	0	0	0
5	4963	1600	1575	1825	2063	0	0	0	0	0	0	0
6	1475	750	188	2025	478	304	365	425	2075	0	0	0
7	3200	700	900	800	600	2388	0	0	0	0	0	0



Min z = 12.91719855(x_{11} + x_{12} + x_{13} + x_{14} + x_{15}) + 11.84458207(x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27}) + 19.29318277(x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{310} + x_{311} + x_{312}) + 14.08265913(x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + x_{48} + x_{49}) + 10.6604771(x_{51} + x_{52} + x_{53} + x_{54} + x_{55}) + 21.43852664(x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{69}) +11.64007481(x_{71} + x_{72} + x_{73} + x_{74} + x_{75} + x_{76})

s.t.

$x_{11} + x_{12} + x_{13} + x_{14} + x_{15}$ <= 14000

$x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27}$ <= 21000

$x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{310} + x_{311} + x_{312}$ <= 21000

$x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + x_{48} + x_{49}$ <= 28000

$x_{51} + x_{52} + x_{53} + x_{54} + x_{55}$ <= 21000

$x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{69}$ <= 14000

$x_{71} + x_{72} + x_{73} + x_{74} + x_{75} + x_{76}$ <= 14000

$700 \le x_{11} \le 975$
$1800 \le x_{12} \le 2400$
$500 \le x_{13} \le 675$
$700 \le x_{14} \le 888$
$2100 \le x_{15} \le 2625$
$800 \le x_{21} \le 1188$
$500 \le x_{22} \le 775$
$3100 \le x_{23} \le 4450$
$400 \le x_{24} \le 660$
$700 \le x_{25} \le 1250$
$550 \le x_{26} \le 888$
$1000 \le x_{27} \le 1400$
$200 \le x_{31} \le 288$
$400 \le x_{32} \le 563$
$300 \le x_{33} \le 430$
$1350 \le x_{34} \le 1813$
$2250 \le x_{35} \le 2813$
$1700 \le x_{36} \le 2338$
$350 \le x_{37} \le 450$
$550 \le x_{38} \le 738$
$1650 \le x_{39} \le 2263$
$350 \le x_{310} \le 638$
$1050 \le x_{311} \le 1550$
$450 \le x_{312} \le 688$
$400 \le x_{41} \le 600$
$3300 \le x_{44} \le 3813$
$4500 \le x_{45} \le 4725$
$1050 \le x_{46} \le 1128$
$4800 \le x_{47} \le 5250$
$1650 \le x_{48} \le 1763$
$2150 \le x_{49} \le 2213$
$4050 \le x_{51} \le 4963$
$1400 \le x_{52} \le 1600$
$1400 \le x_{53} \le 1575$
$1400 \le x_{54} \le 1825$
$1800 \le x_{55} \le 2063$
$1150 \le x_{61} \le 1475$
$550 \le x_{62} \le 750$
$100 \le x_{63} \le 188$
$1750 \le x_{64} \le 2025$
$345 \le x_{65} \le 478$
$210 \le x_{66} \le 304$
$250 \le x_{67} \le 365$
$290 \le x_{68} \le 425$
$1750 \le x_{69} \le 2075$
$2400 \le x_{71} \le 3200$
$400 \le x_{72} \le 700$
$600 \le x_{73} \le 900$
$500 \le x_{74} \le 800$
$400 \le x_{75} \le 600$
$1850 \le x_{76} \le 2388$

Solution for model 1

D25 =SUMPRODUCT(C4:N10,C14:N20)

	1	2	3	4	5	6	7	8	9	10	11	12
1	12.91719855	12.91719855	12.91719855	12.91719855	12.91719855	0	0	0	0	0	0	0
2	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	0	0	0	0	0
3	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277
4	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	0	0	0
5	10.6604771	10.6604771	10.6604771	10.6604771	10.6604771	0	0	0	0	0	0	0
6	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	0	0	0
7	11.64007481	11.64007481	11.64007481	11.64007481	11.64007481	11.64007481	0	0	0	0	0	0

	1	2	3	4	5	6	7	8	9	10	11	12			Supply
1	975	2400	675	888	2625	0	0	0	0	0	0	0	7563	<=	14000
2	1188	775	4450	660	1250	888	1400	0	0	0	0	0	10611	<=	21000
3	200	400	300	1350	2250	2120	450	738	2263	638	1550	688	12947	<=	21000
4	600	1813	565	3813	4725	1128	5250	1763	2213	0	0	0	21870	<=	28000
5	4963	1600	1575	1825	2063	0	0	0	0	0	0	0	12026	<=	21000
6	1150	550	100	1750	345	210	250	290	1750	0	0	0	6395	<=	14000
7	3200	700	900	800	600	2388	0	0	0	0	0	0	8588	<=	14000
	1	2	3	4	5	6	7	8	9	10	11	12			
													80000	>=	80000

MIN COST	1146419.463

Model 2

Transformation cost per shirt each route

Q13 14000

	1	2	3	4	5	6	7	8	9	10	11	12
1	12.91719855	12.91719855	12.91719855	12.91719855	12.91719855	0	0	0	0	0	0	0
2	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	11.84458207	0	0	0	0	0
3	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277	19.29318277
4	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	14.08265913	0	0	0
5	10.6604771	10.6604771	10.6604771	10.6604771	10.6604771	0	0	0	0	0	0	0
6	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	21.43852664	0	0	0
7	11.64007481	11.64007481	11.64007481	11.64007481	11.64007481	11.64007481	0	0	0	0	0	0

Max supply each route

Solution for how do distribute the shirts each route

															Supply
1													0	<=	14000
2													0	<=	21000
3													0	<=	21000
4													0	<=	28000
5													0	<=	21000
6													0	<=	14000
7													0	<=	14000
	1	2	3	4	5	6	7	8	9	10	11	12			
													0	>=	90000

MIN COST	0

Average value of three-month shirts

Specified number of shirts to be distributed

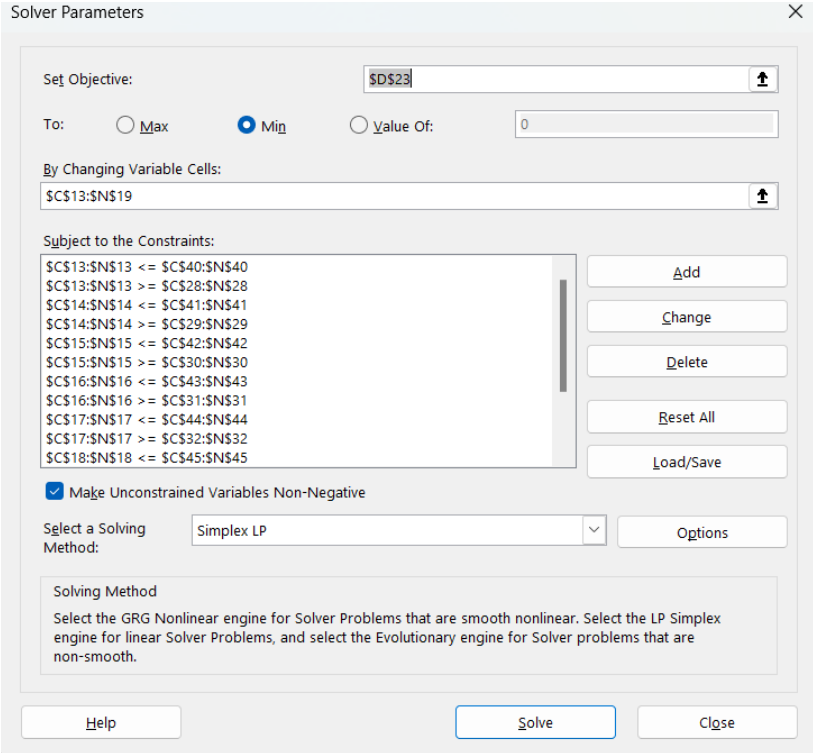
AVG Values

1	2	3	4	5	6	7	8	9	10	11	12	
975	2400	675	888	2625	0	0	0	0	0	0	0	7563
1188	775	4450	660	1250	888	1400	0	0	0	0	0	10611
288	563	430	1813	2813	2338	450	738	2263	638	1550	688	14572
600	1813	565	3813	4725	1128	5250	1763	2213	0	0	0	21870
4963	1600	1575	1825	2063	0	0	0	0	0	0	0	12026
1475	750	188	2025	478	304	365	425	2075	0	0	0	8085
3200	700	900	800	600	2388	0	0	0	0	0	0	8588

The maximize value of three-month average shirts

Max Values

1	2	3	4	5	6	7	8	9	10	11	12	
1300	2900	800	1000	2900	0	0	0	0	0	0	0	8900
1550	1000	5650	800	1650	1200	1800	0	0	0	0	0	13650
400	650	550	2100	3250	2950	550	900	2800	900	2050	900	18000
750	1900	800	4200	5100	1160	5600	1850	2350	0	0	0	23710
6900	2100	1800	2400	2200	0	0	0	0	0	0	0	15400
1900	1050	300	2500	680	410	450	550	2500	0	0	0	10340
4300	1000	1350	1100	800	3100	0	0	0	0	0	0	11650



Min z = 12.91719855($x_{11} + x_{12} + x_{13} + x_{14} + x_{15}$) + 11.84458207($x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27}$) + 19.29318277($x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{310} + x_{311} + x_{312}$) + 14.08265913($x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + x_{48} + x_{49}$) + 10.6604771($x_{51} + x_{52} + x_{53} + x_{54} + x_{55}$) + 21.43852664($x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{69}$) +11.64007481($x_{71} + x_{72} + x_{73} + x_{74} + x_{75} + x_{76}$)

s.t.

$x_{11} + x_{12} + x_{13} + x_{14} + x_{15}$ <= 14000

$x_{21} + x_{22} + x_{23} + x_{24} + x_{25} + x_{26} + x_{27}$ <= 21000

$x_{31} + x_{32} + x_{33} + x_{34} + x_{35} + x_{36} + x_{37} + x_{38} + x_{39} + x_{310} + x_{311} + x_{312}$ <= 21000

$x_{41} + x_{42} + x_{43} + x_{44} + x_{45} + x_{46} + x_{47} + x_{48} + x_{49}$ <= 28000

$x_{51} + x_{52} + x_{53} + x_{54} + x_{55}$ <= 21000

$x_{61} + x_{62} + x_{63} + x_{64} + x_{65} + x_{66} + x_{67} + x_{68} + x_{69}$ <= 14000

$x_{71} + x_{72} + x_{73} + x_{74} + x_{75} + x_{76}$ <= 14000

$975 \leq x_{11} \leq 1300$
$2400 \leq x_{12} \leq 2900$
$675 \leq x_{13} \leq 800$
$888 \leq x_{14} \leq 1000$
$2625 \leq x_{15} \leq 2900$
$1188 \leq x_{21} \leq 1550$
$775 \leq x_{22} \leq 1000$
$4450 \leq x_{23} \leq 5650$
$660 \leq x_{24} \leq 800$
$1250 \leq x_{25} \leq 1650$
$888 \leq x_{26} \leq 1200$
$1400 \leq x_{27} \leq 1800$
$288 \leq x_{31} \leq 400$
$563 \leq x_{32} \leq 650$
$430 \leq x_{33} \leq 550$
$1813 \leq x_{34} \leq 2100$
$2813 \leq x_{35} \leq 3250$
$2338 \leq x_{36} \leq 2950$
$450 \leq x_{37} \leq 550$
$738 \leq x_{38} \leq 900$
$2263 \leq x_{39} \leq 2800$
$638 \leq x_{310} \leq 900$
$1550 \leq x_{311} \leq 2050$
$688 \leq x_{312} \leq 900$
$600 \leq x_{41} \leq 750$
$1813 \leq x_{42} \leq 1900$
$565 \leq x_{43} \leq 800$
$3813 \leq x_{44} \leq 4200$
$4725 \leq x_{45} \leq 5100$
$1128 \leq x_{46} \leq 1160$
$5250 \leq x_{47} \leq 5600$
$1763 \leq x_{48} \leq 1850$
$2213 \leq x_{49} \leq 2350$
$4963 \leq x_{51} \leq 6900$
$1600 \leq x_{52} \leq 2100$
$1575 \leq x_{53} \leq 1800$
$1825 \leq x_{54} \leq 2400$
$2063 \leq x_{55} \leq 2200$
$1475 \leq x_{61} \leq 1900$
$750 \leq x_{62} \leq 1050$
$188 \leq x_{63} \leq 300$
$2025 \leq x_{64} \leq 2500$
$478 \leq x_{65} \leq 680$
$304 \leq x_{66} \leq 410$
$365 \leq x_{67} \leq 450$
$425 \leq x_{68} \leq 550$
$2075 \leq x_{69} \leq 2500$
$3200 \leq x_{71} \leq 4300$
$700 \leq x_{72} \leq 1000$
$900 \leq x_{73} \leq 1350$
$800 \leq x_{74} \leq 1100$
$600 \leq x_{75} \leq 800$
$2388 \leq x_{76} \leq 3100$

Solution for model 2

D23 =SUMPRODUCT(C3:N9,C13:N19)

	1	2	3	4	5	6	7	8	9	10	11	12
1	12.9171986	12.9171986	12.9171986	12.9171986	12.9171986	0	0	0	0	0	0	0
2	11.8445821	11.8445821	11.8445821	11.8445821	11.8445821	11.8445821	11.8445821	0	0	0	0	0
3	19.2931828	19.2931828	19.2931828	19.2931828	19.2931828	19.2931828	19.2931828	19.2931828	19.2931828	19.2931828	19.2931828	19.2931828
4	14.0826591	14.0826591	14.0826591	14.0826591	14.0826591	14.0826591	14.0826591	14.0826591	14.0826591	0	0	0
5	10.6604771	10.6604771	10.6604771	10.6604771	10.6604771	0	0	0	0	0	0	0
6	21.4385266	21.4385266	21.4385266	21.4385266	21.4385266	21.4385266	21.4385266	21.4385266	21.4385266	0	0	0
7	11.6400748	11.6400748	11.6400748	11.6400748	11.6400748	11.6400748	0	0	0	0	0	0

															Supply
1	936	2700	711	1026	2853	0	0	0	0	0	0	0	8226	<=	14000
2	1296	846	4770	666	1377	981	1530	0	0	0	0	0	11466	<=	21000
3	315	630	486	1935	3033	2583	486	810	2511	738	1746	783	16056	<=	21000
4	693	1944	639	4095	5112	1242	5769	1926	2385	0	0	0	23805	<=	28000
5	4977	1584	1710	1836	2214	0	0	0	0	0	0	0	12321	<=	21000
6	1566	810	261	2214	576	369	387	477	2241	0	0	0	8901	<=	14000
7	3366	765	990	873	648	2592	0	0	0	0	0	0	9234	<=	14000
	1	2	3	4	5	6	7	8	9	10	11	12			133000
													90009	>=	90000

MIN COST	1316732.41

4. SOLUTION

We have mentioned 2 grant methods to get solutions on the previous pages.

- One of the is to get solutions from using the model formulation.
- The other is to calculate the percentage and solutions.

Model Solution

The answer received after putting in the 97000 shirts of to our model,

Total Shirts	**97000**											
	Digana	Mahiyangana	Padiyathalawa	Mahaoya	Batticallo							
Batticallo Route	1300	2900	800	1000	2900	0	0	0	0	0	0	0
	Katugasthota	Mawathagama	Kurunagala	Wariyapola	Nikawaratiya	Anamaduwa	Puththalam					
Puththalam Route	1550	1000	5650	800	1650	1200	1800	0	0	0	0	0
	Pilimathalawa	Kadugannawa	Mawanalla	Kegall	Kadawatha	Galle	Ahangama	Mirissa	Matara	Dickwella	Tangalle	Hambanthota
Hambanthota Route	288	563	430	1813	2813	2338	450	738	2322	900	2050	900
	Warakapola	Nittambuwa	Yakkala	Kiribathgoda	Colombo	Kottawa	Maharagama	Piliyandala	Malambe			
Colombo Route	750	1900	800	4200	5100	1160	5600	1850	2350	0	0	0
	Kandy	Gampola	Nuwaraeliya	Walimada	Badulla							
Badulla Route	6900	2100	1800	2400	2200	0	0	0	0	0	0	0
	Dambulla	Kakirawa	Thalawa	Anuradhapura	Mihinthale	Madawachchiya	Wauniyawa	Kilinochchiya	Jaffna			
Jaffna Route	1475	750	188	2025	478	304	365	425	2075	0	0	0
	Matale	Naula	Dambulla	Habarana	Kanthale	Trinco						
Trinco Route	4300	1000	1350	1100	800	3100	0	0	0	0	0	0

Calculate the percentage and get solutions

The answer received after calculating 97000 shirts using the percentage method.

Enter Total Shirts 97000

Estimate Shirts Demands

Batticallo

Total Transport cost per shirt 10.898582

Digana	Mahiyangana	Padiyathalawa	Mahaoya	Batticallo
1009	2910	766	1106	3075

Puththalam

Total Transport cost per shirt 9.4865582

Katugasthot	Mawathagam:	Kurunagal:	Wariyapola	Nikawaratiya	Anamaduw:	Puththalam
1397	912	5141	718	1484	1057	1649

Baddulla

Total Transport cost per shirt 9.4086

Kandy	Gampola	Nuwaraeliya	Walimada	Badulla
5364	1707	1843	1979	2386

Hambanthota

Total Transport cost per shirt 15.629584

Pilimathalawa	Kadugannaw:	Mawanalla	Kegall	Kadawatha	Galle	Ahangama	Mirissa	Matara	Dickwella	Tangalle	Hambanthota
340	679	524	2086	3269	2784	524	873	2706	795	1882	844

Trinco

Total Transport cost per shirt 9.4658378

Matale	Naula	Dambulla	Habarana	Kanthale	Trinco
3628	825	1067	941	698	2794

Colombo

Total Transport cost per shirt 11.969556

Warakapola	Nittambuwa	Yakkala	Kiribathgoda	Colombo	Kottawa	Maharagama	Piliyandala	Malambe
747	2095	689	4414	5510	1339	6218	2076	2571

Jaffna

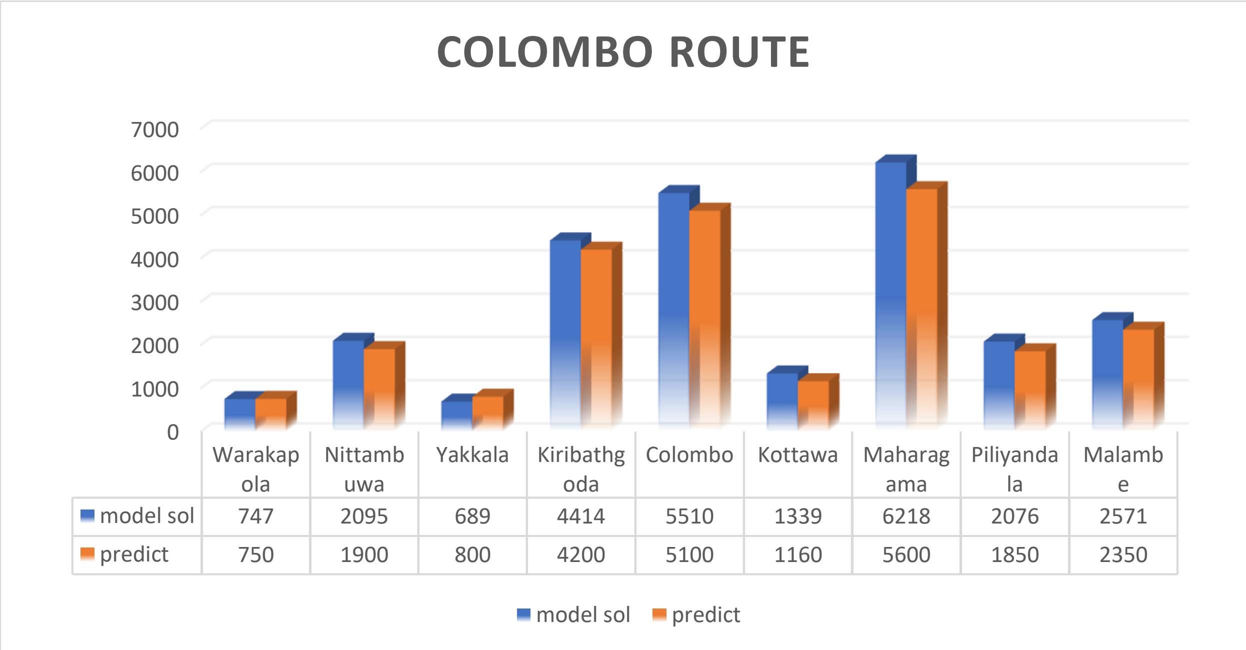
Total Transport cost per shirt 17.483858

Dambulla	Kakirawa	Thalawa	Anuradhapur:	Mihinthale	Madawachchiya	Wauniyawa	Kilinochchiya	Jaffna
1688	873	281	2386	621	398	417	514	2415

This is a chart that can be an idea about the amount of shirts to put in each city after combining the results from our model solutions and the percentage calculation.

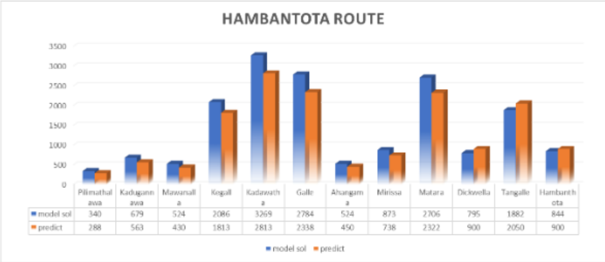
Blue color – model solution

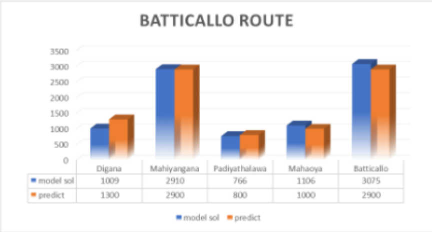
Brown color – percentage calculation results

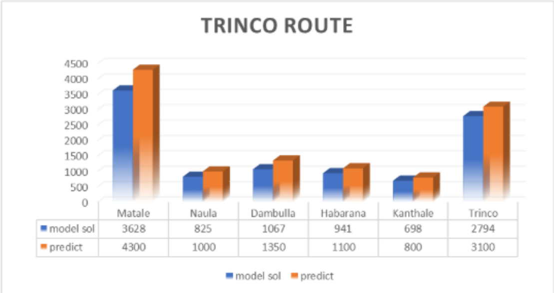


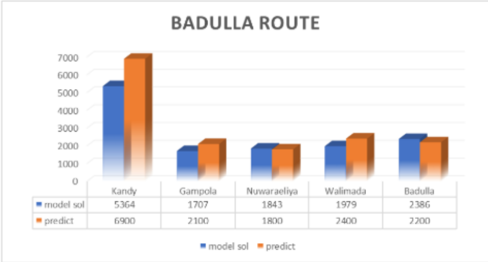
When 97000 shirts were given in the Colombo route, the answers obtained by the 2 methods of model formulation and using percentage are mentioned in this bar chart. According to the chart, it seems that both methods have obtained approximate values. A round value between those values is given to the sales reps as the target.

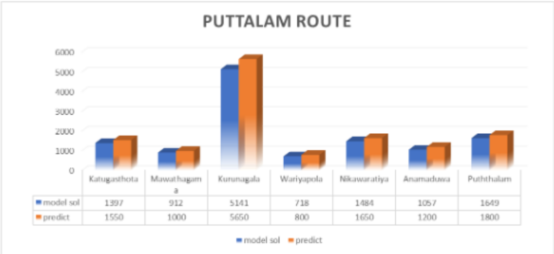
Now if we take Kiribathgoda, it seems that 4414 has been obtained by the model formulation and 4200 by calculate the percentage and solutions. An approximate value between these values can be given as the target. It will give a profitable answer.

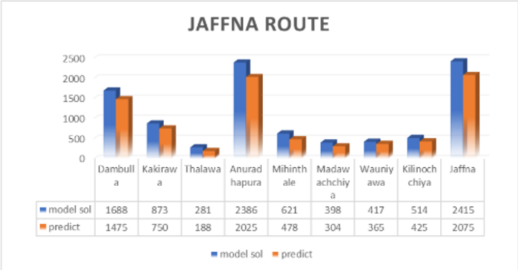












The Impact of Our Smart System

Challenges Faced Before the System

Before the introduction of modern systems, the challenges faced due to manual data recording and difficulty analyzing demand trends were significant. These challenges led to operational inefficiencies, delays, and poor decision-making. Here's a closer look at the specific difficulties faced:

1. **Sales representatives manually record data in notebooks:**

Data entry errors made by humans: Errors including typos, incorrect calculations, or misinterpretations were common among sales representatives who manually recorded data in notebooks. Order fulfilment, inventory control,

and customer happiness were all influenced by these frequently overlooked errors.
Unstructured and inconsistent data: It might be challenging to compile or analyse data that is recorded by many sales representatives in different formats or with different degrees of detail. When comparing sales data, stocks, or client preferences, this mismatch may cause disparities.

Risk of Data Loss: Vital sales data may have been lost since physical notebooks were prone to damage. It was expensive and time-consuming to restore lost data.

2 . Challenges Planning Production and Delivery by Examining Demand Trends:

Absence of centralised information Sales records were frequently scattered in various forms or places due to the manual recording of data. It was difficult to aggregate and consolidate this data, which made obtaining a comprehensive picture of client demand difficult.

Analysis and reporting were delayed because data entry was done by hand, which resulted in a longer time to examine demand and sales trends. Due to the out-of-date insights produced by this delayed reporting, firms were ill-equipped to respond to changes in customer preferences or market conditions.

Benefits of the App and Dashboard System

There are several advantages to introducing an app and dashboard system, particularly when it comes to tackling the difficulties associated with manual data collecting, production scheduling, and delivery management. The system improves operational efficiency, decision-making, and accuracy by automating and simplifying procedures. The precise advantages are as follows:

1.Simplified Demand Data Gathering

Sales representatives no longer need manual notebooks because they can enter data straight into the app. This guarantees precision and minimizes human errors like incorrect computations or unreadable handwriting.

Real-Time Updates: The centralised system immediately updates sales data as it is entered. This makes it possible to monitor demand in real time, guaranteeing that data is always up to date and available.

2. Better Production and Delivery Scheduling:

Enhanced Production Timetables with real-time, precise demand data collection, production teams can more accurately predict demand and modify production plans as necessary. This ensures resource efficiency by lowering overproduction or underproduction.

3.Real-Time Information to Help Make Better Decisions:

Quick Data Access: Decision-makers are able to monitor demand patterns and key performance indicators (KPIs) in real time thanks to dashboards' insights and visualizations. This facilitates the prompt identification of problems or possibilities.

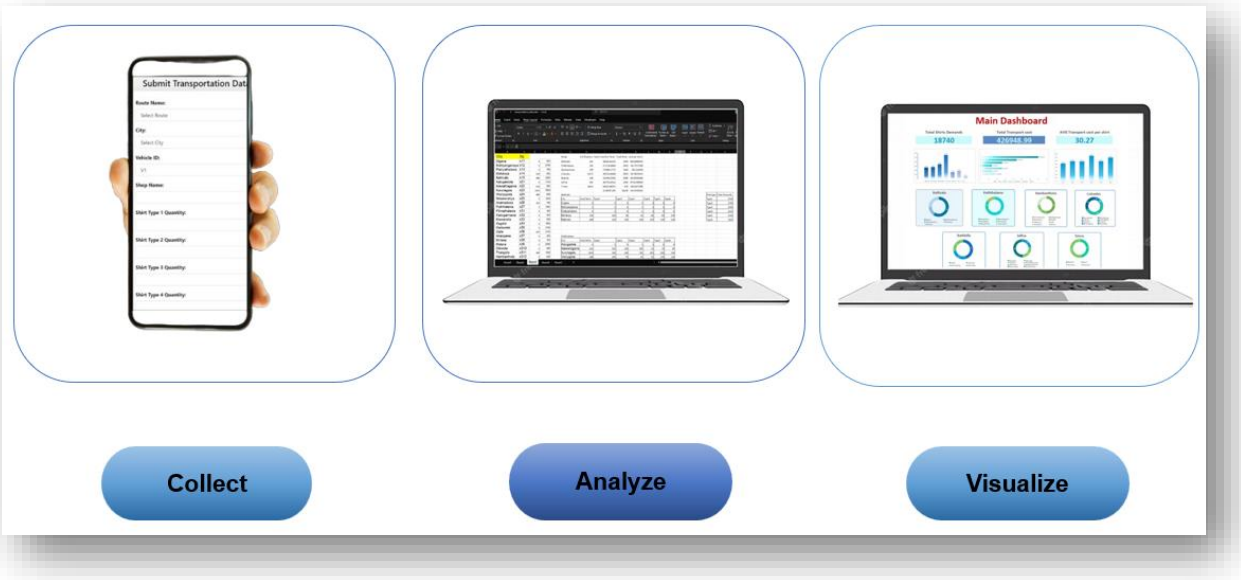
5. EXCEL DASHBOARD SYSTEM

Our App and Dashboards

Provide a brief overview of the system, highlighting how the Flask App and dashboards work together to streamline demand data collection and analysis for the garment company.

Mention the transition from manual methods to a digital solution:

- Flask App: Enables sales representatives to digitally record demand data.
- Excel Backend: Organizes and processes the data for analysis.
- Dashboards: Visualize trends and insights to assist management in decision-making.



Details About the Flask App

1.**Purpose**

- Designed for sales representatives who collect demand data during shop visits.
- Automates data recording, reducing human errors and improving efficiency.

2.**Key Features**

User-Friendly Interface

- Drop-down menus for selecting routes, cities, vehicle IDs, and shops.
- Input fields for entering shirt quantities (Type 1 to Type 6).
- Automatic recording of date and time for each entry.

Dynamic Options

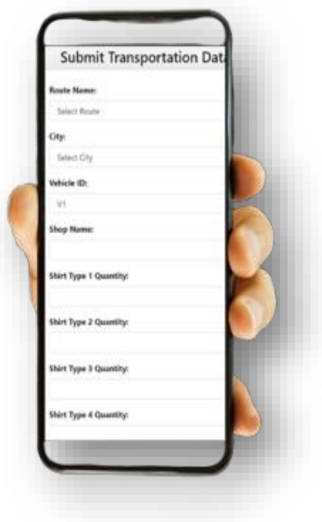
- Cities update dynamically based on the selected route name.

Excel Integration

- The app directly updates the Excel backend in real-time with all inputs.

Error Prevention

- Validation rules ensure correct data entry (e.g., positive values only).



3.How It Works

- Sales representatives select the route and city and enter the shop's demand data via the app.
- The app validates and saves the input data to an Excel file.
- Excel organizes the data into tables, ready for analysis.

4.Technical Details

Backend Framework: Flask (Python)

Flask is an ideal choice for this project due to its simplicity and modular design, which make it perfect for rapid application development. Its seamless integration with Python libraries like Pandas allows for efficient data handling and processing, ensuring smooth interaction with the Excel backend. Additionally, Flask's scalability ensures that the app can accommodate an increasing number of users and data entries as the garment company grows, making it a reliable solution for both current and future needs

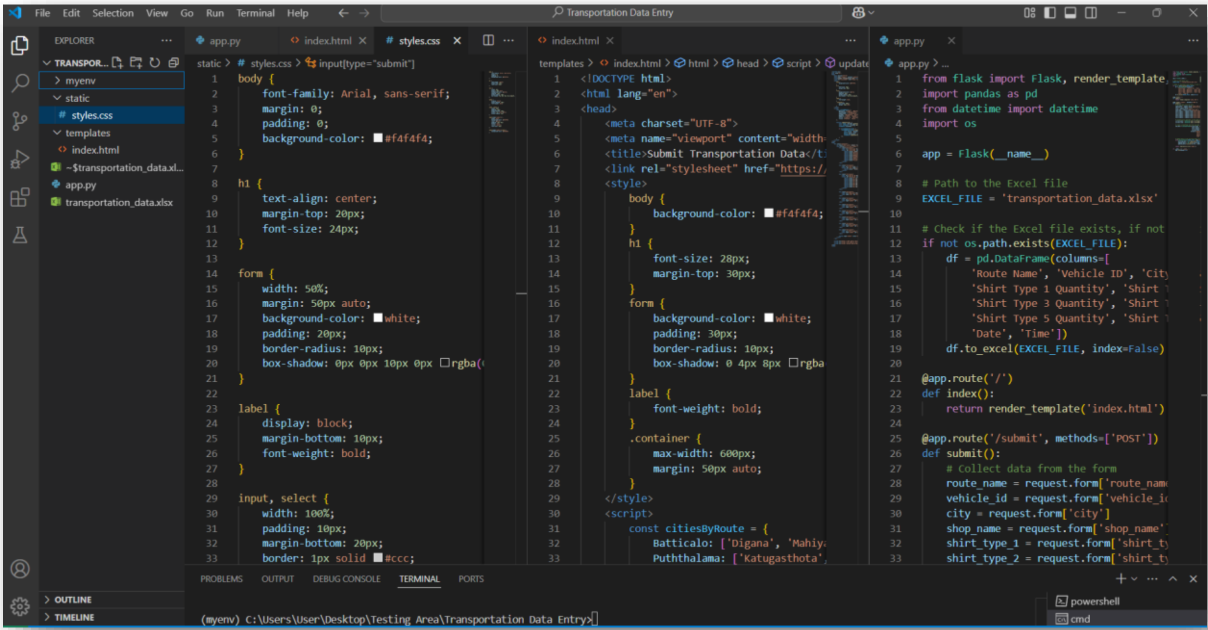
Frontend - HTML/CSS

HTML

- Used to design the structure of the app's user interface.
- Includes form fields for input (e.g., dropdowns for routes, vehicles, cities, and shops; text fields for shirt quantities).

CSS

- Styled the app to create an intuitive and user-friendly design.
- Ensures the interface is clean and responsive, allowing sales reps to easily input data even on smaller devices like tablets



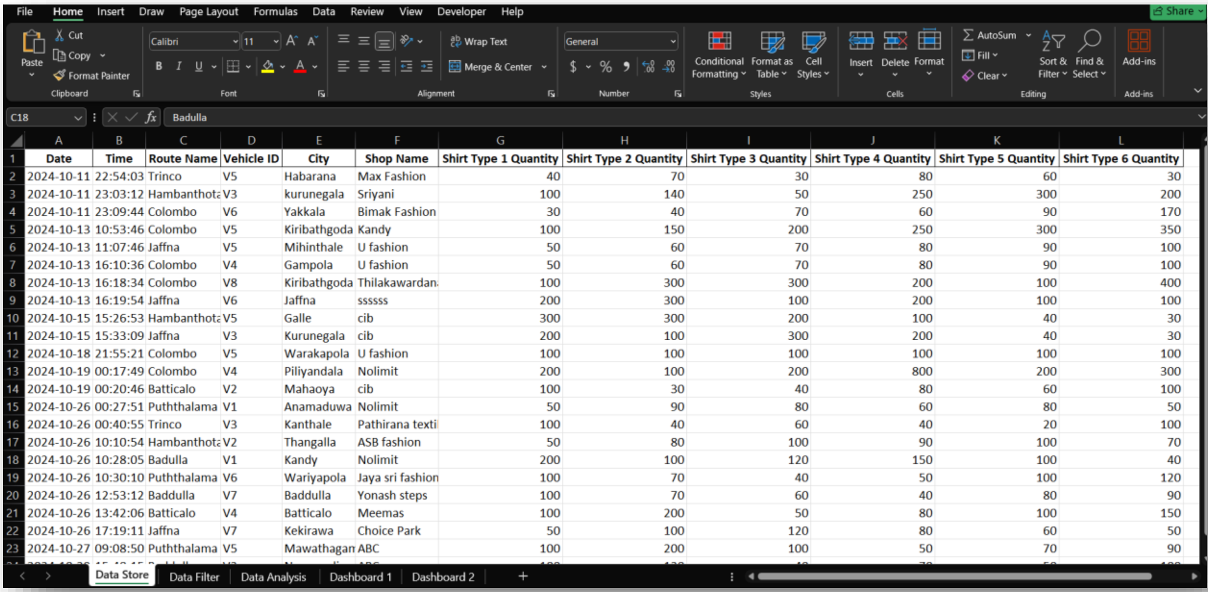
Excel Backend

Role

- Acts as the centralized database for storing demand data.
- Performs all backend calculations and data preparation for dashboards.

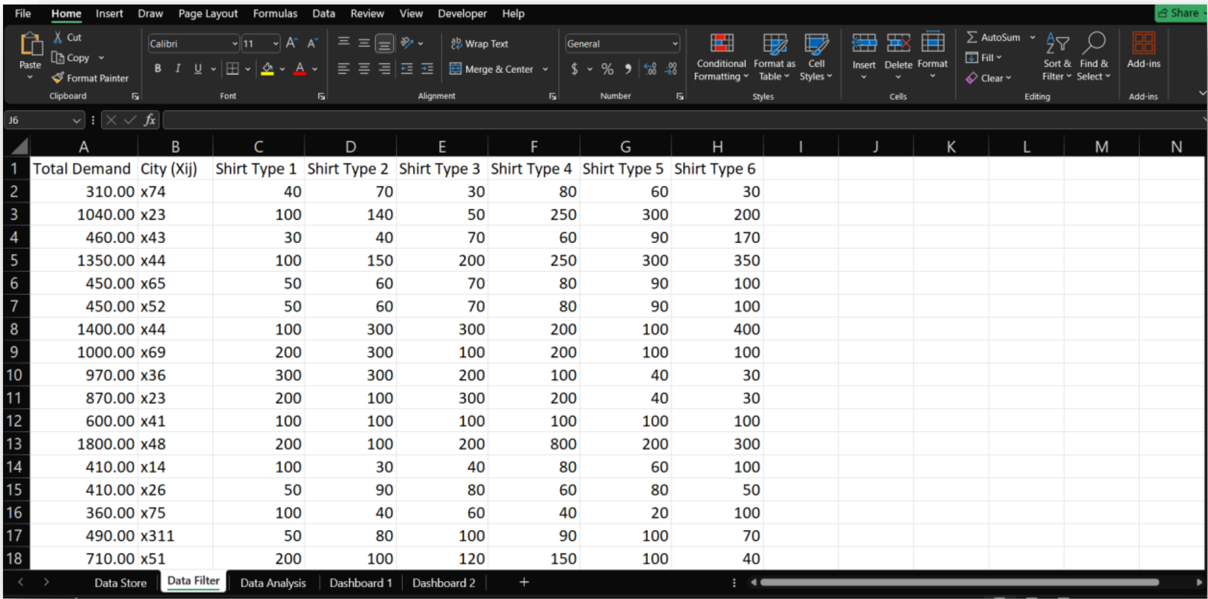
Key Functions

Data Storage - The system stores all demand data in an organized tabular format, capturing key details such as date, route, city, shop, and quantities for each shirt type. This ensures a centralized and accessible repository for tracking demand.



Date	Time	Route Name	Vehicle ID	City	Shop Name	Shirt Type 1 Quantity	Shirt Type 2 Quantity	Shirt Type 3 Quantity	Shirt Type 4 Quantity	Shirt Type 5 Quantity	Shirt Type 6 Quantity
2024-10-11	22:54:03	Trinco	V5	Habarana	Max Fashion	40	70	30	80	60	30
2024-10-11	23:03:12	Hambanthot	V3	kurunegala	Sriyani	100	140	50	250	300	200
2024-10-11	23:09:44	Colombo	V6	Yakkala	Bimak Fashion	30	40	70	60	90	170
2024-10-13	10:53:46	Colombo	V5	Kiribathgoda	Kandy	100	150	200	250	300	350
2024-10-13	11:07:46	Jaffna	V5	Mihinthale	U fashion	50	60	70	80	90	100
2024-10-13	16:10:36	Colombo	V4	Gampola	U fashion	50	60	70	80	90	100
2024-10-13	16:18:34	Colombo	V8	Kiribathgoda	Thilakawardan	100	300	300	200	100	400
2024-10-13	16:19:54	Jaffna	V6	Jaffna	ssssss	200	300	100	200	100	100
2024-10-15	15:26:53	Hambanthot	V5	Galle	cib	300	300	200	100	40	30
2024-10-15	15:33:09	Jaffna	V3	Kurunegala	cib	200	100	300	200	40	30
2024-10-18	21:55:21	Colombo	V5	Warakapola	U fashion	100	100	100	100	100	100
2024-10-19	00:17:49	Colombo	V4	Piliyandala	Nolimit	200	100	200	800	200	300
2024-10-19	00:20:46	Batticalo	V2	Mahaoya	cib	100	30	40	80	60	100
2024-10-26	00:27:51	Puththalama	V1	Anamaduwa	Nolimit	50	90	80	60	80	50
2024-10-26	00:40:55	Trinco	V3	Kanthale	Pathirana texti	100	40	60	40	20	100
2024-10-26	10:10:54	Hambanthot	V2	Thangalla	ASB fashion	50	80	100	90	100	70
2024-10-26	10:28:05	Badulla	V1	Kandy	Nolimit	200	100	120	150	100	40
2024-10-26	10:30:10	Puththalama	V6	Wariyapola	Jaya sri fashion	100	70	40	50	100	120
2024-10-26	12:53:12	Baddulla	V7	Baddulla	Yonash steps	100	70	60	40	80	90
2024-10-26	13:42:06	Batticalo	V4	Batticalo	Meemas	100	200	50	80	100	150
2024-10-26	17:19:11	Jaffna	V7	Kekirawa	Choice Park	50	100	120	80	60	50
2024-10-27	09:08:50	Puththalama	V5	Mawathagan	ABC	100	200	100	50	70	90

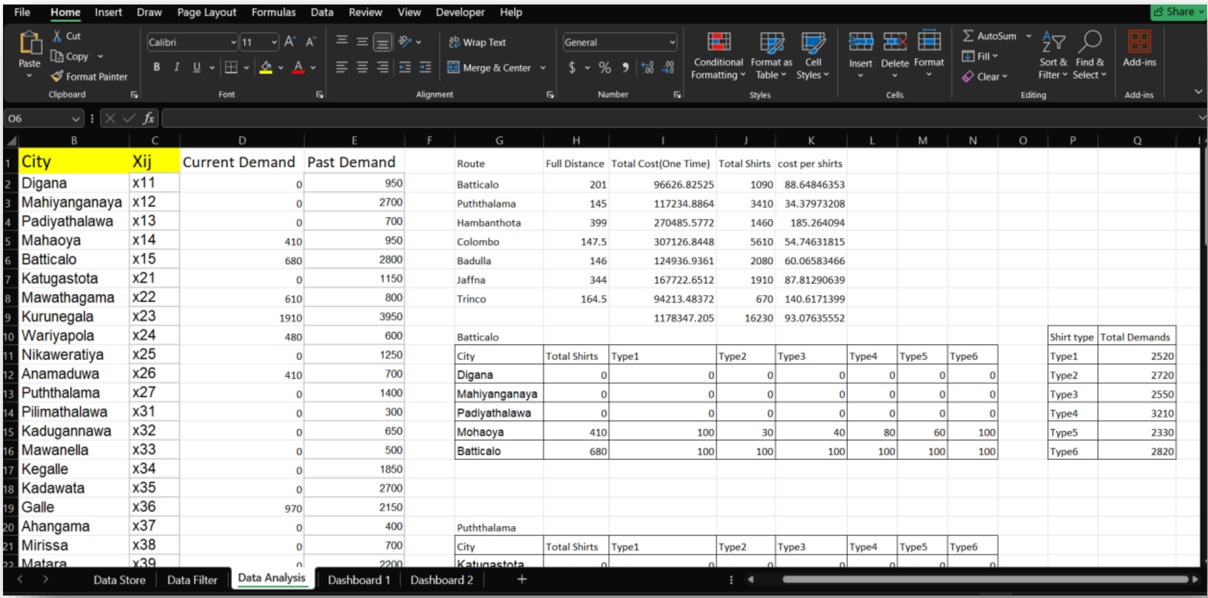
Data Filtering - Filtering mechanisms are implemented in the Excel backend to extract relevant data from the storage sheet for specific calculations and analyses. This ensures that only pertinent data is used for accurate reporting and decision-making.



Total Demand	City (Xij)	Shirt Type 1	Shirt Type 2	Shirt Type 3	Shirt Type 4	Shirt Type 5	Shirt Type 6
310.00	x74	40	70	30	80	60	30
1040.00	x23	100	140	50	250	300	200
460.00	x43	30	40	70	60	90	170
1350.00	x44	100	150	200	250	300	350
450.00	x65	50	60	70	80	90	100
450.00	x52	50	60	70	80	90	100
1400.00	x44	100	300	300	200	100	400
1000.00	x69	200	300	100	200	100	100
970.00	x36	300	300	200	100	40	30
870.00	x23	200	100	300	200	40	30
600.00	x41	100	100	100	100	100	100
1800.00	x48	200	100	200	800	200	300
410.00	x14	100	30	40	80	60	100
410.00	x26	50	90	80	60	80	50
360.00	x75	100	40	60	40	20	100
490.00	x311	50	80	100	90	100	70
710.00	x51	200	100	120	150	100	40

Data Analysis - Advanced Excel functionalities like VLOOKUP, SUMIF, and pivot tables are utilized to identify trends, calculate aggregate metrics, and generate insights into demand patterns.

Error Checking - Validation rules and conditional formatting are applied to maintain data accuracy by flagging inconsistencies and errors during data entry.



City	Xij	Current Demand	Past Demand
Digana	x11	0	950
Mahiyanganaya	x12	0	2700
Padiyathalawa	x13	0	700
Mahaoya	x14	410	950
Batticalo	x15	680	2800
Katugastota	x21	0	1150
Mawathagama	x22	610	800
Kurunegala	x23	1910	3950
Wariyapola	x24	480	600
Nikaweratiya	x25	0	1250
Anamaduwa	x26	410	700
Puththalama	x27	0	1400
Pilimathalawa	x31	0	300
Kadugannawa	x32	0	650
Mawanella	x33	0	500
Kegalle	x34	0	1850
Kadawata	x35	0	2700
Galle	x36	970	2150
Ahangama	x37	0	400
Mirissa	x38	0	700
Matara	x39	0	2200

Route	Full Distance	Total Cost(One Time)	Total Shirts	cost per shirts
Batticalo	201	96626.82525	1090	88.64846353
Puththalama	145	117234.8864	3410	34.37973208
Hambanthota	399	270485.5772	1460	185.264094
Colombo	147.5	307126.8448	5610	54.74631815
Badulla	146	124936.9361	2080	60.06583466
Jaffna	344	167722.6512	1910	87.81290639
Trinco	164.5	94213.48372	670	140.6171399
		1178347.205	16230	93.07635552

Batticalo

City	Total Shirts	Type1	Type2	Type3	Type4	Type5	Type6
Digana	0	0	0	0	0	0	0
Mahiyanganaya	0	0	0	0	0	0	0
Padiyathalawa	0	0	0	0	0	0	0
Mohaoya	410	100	30	40	80	60	100
Batticalo	680	100	100	100	100	100	100

Shirt type	Total Demands
Type1	2520
Type2	2720
Type3	2550
Type4	3210
Type5	2330
Type6	2820

Puththalama

City	Total Shirts	Type1	Type2	Type3	Type4	Type5	Type6
Katugastota	0	0	0	0	0	0	0

Outputs Prepared:

Summary Sheets:

- Total shirt demand for each type.
- Regional and city-specific demand insights.
- Identification of high-demand shops and routes.

Detailed Route Analysis:

- Total shirt demand in each route.
- Transport cost per shirt for each route.
- Average transport cost per shirt across all routes.

Aggregate Demand and Cost Metrics:

- Total demand for each shirt type.
- Total transport cost for all routes.

Trend Analysis:

- Comparison of previous shirt demand data with current demand to identify growth patterns or areas needing improvement.

Dashboard 1 - Main Dashboard

Purpose

The Main Dashboard serves as a comprehensive overview of shirt demand trends across all routes and cities. It provides sales representatives and decision-makers with key metrics and visualizations to understand demand distribution, transport costs, and trends over time.

Key Features

1. Total Shirts Demands

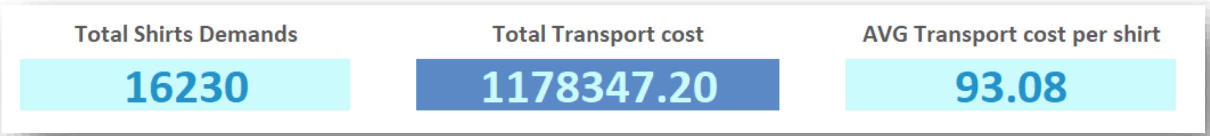
   Displays the total number of shirts demanded across all routes and cities, providing a high-level summary of overall demand.

2. Total Transport cost

   Highlights the total cost incurred for transporting shirts, giving insights into logistics expenses.

3. AVG Transport cost per shirt

   Shows the average transportation cost per shirt, helping to evaluate cost efficiency.



4. Total Shirts Demands in each Routes

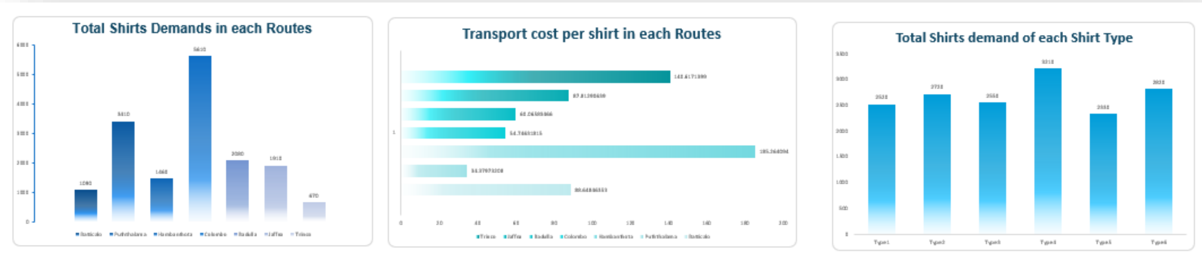
A visual representation of shirt demands broken down by route, helping identify high-demand routes.

5. Transport cost per shirt in each Routes

   Displays the cost per shirt for each route, enabling route-specific cost analysis.

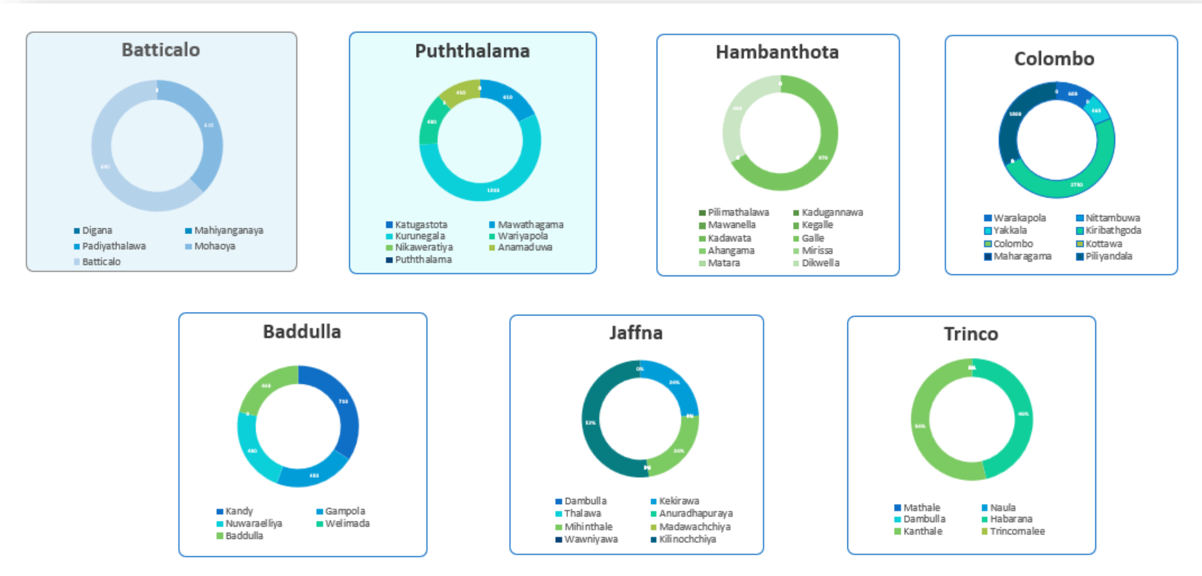
6. Total Shirts demand of each Shirt Type

   A breakdown of the total demand for each shirt type, aiding in production planning.



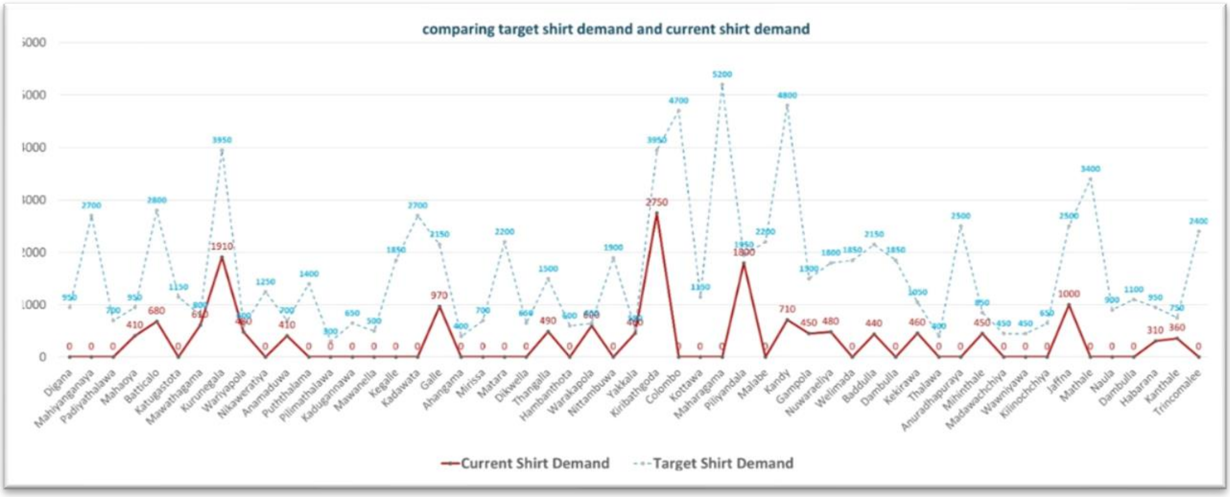
7. All rotes wise city demands

   Each donut chart represents the demand distribution among cities within a specific route, providing a detailed regional view.



8. comparing target shirt demand and current shirt demand

This chart compares target demand data with current trends, enabling analysis of growth patterns or fluctuations in demand.



Dashboard 2 - Details Dashboard

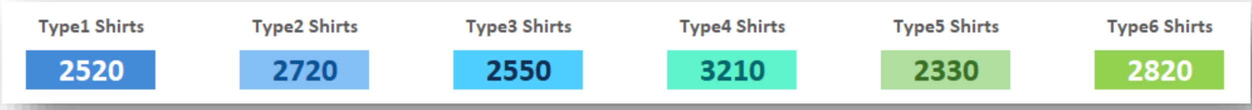
Purpose

The Details Dashboard focuses on specific routes and cities to enable granular analysis for optimizing delivery schedules and supply chain planning. It provides route-specific and city-level demand insights to assist with efficient resource allocation and delivery strategies.

Key Features

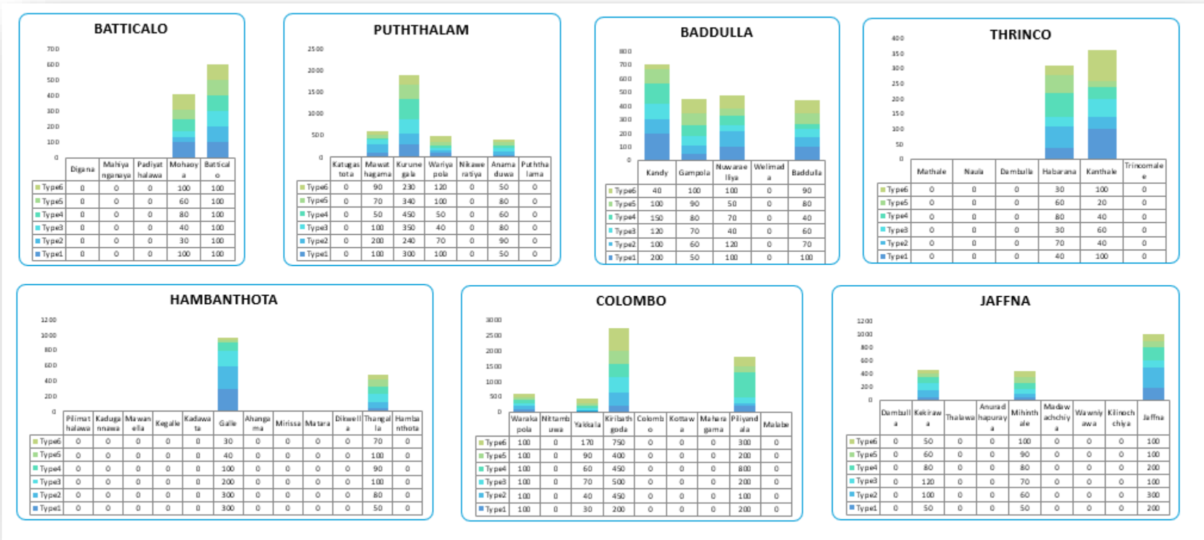
1. Total Demand of Each Shirt Type
    - Displays the aggregate demand for each shirt type across all routes and cities.

Provides insights into overall product popularity, assisting in **inventory** and production planning.



2. Route-Wise Each Shirt Type Demand

    - A detailed visualization of the demand for each shirt type, categorized by routes.
    - Helps identify which shirt types are in higher demand in specific routes, enabling precise production and delivery planning.



6. RESULTS

- **Cost Minimization:** The linear programming model identified optimal routes, significantly reducing transportation costs.

- **Dashboard Insights:** The Excel dashboard provided a clear view of cost allocation across routes, allowing quick identification of high-cost routes or expense categories.

7. CONCLUSION AND RECOMMENDATIONS

7.1 Assumptions

While our results show encouraging results, it's important to acknowledge some of the assumptions that were made during the research.

- The company produces six types of shirts. In this model, the sales quantity of these six types is considered as an order quantity, assuming one shirt per order.
- For a given route, the transportation cost per shirt to each store along that route is uniform.
- Transportation costs vary between different routes.
- All trucks in the company have the same capacity and same maintenance cost.

7.2 Limitations

Despite the positive results, Our study has limitations that should be considered.

- Data collecting: Only four years of sales data were available, and the data was recorded irregularly.

- Generalization of the model: The variable Xij represents the target quantity of shirts to be sold in a city. However, the model does not provide a distribution of this target quantity across individual stores within that city.

7.3 Conclusion

This project provides valuable insights into the company's sales performance by analyzing data route-wise and store-wise along each route. By comparing the company's target quantities with actual orders received through sales agents, the model identifies gaps and highlights potential inefficiencies. If order quantities fall short of target quantities, this analysis can serve as a foundation for developing alternative strategies to enhance sales performance.

Additionally, the model facilitates better planning and resource allocation by offering clarity on sales trends across different routes and stores.

7.4 Future work

Currently, the model aggregates sales data for six types of shirts into a single order quantity. Future improvements aim to develop a more advanced model that maximizes company profits by analyzing and optimizing the sales performance of each shirt type individually.

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- Fuel Prices : https://ceypetco.gov.lk/marketing-sales/
- Map: https://www.google.com/maps/@7.2619129,80.5994496,15z?entry=ttu&g_ep=EgoyMDI0MTIxMS4wIKXMDSoASAFQAw%3D%3D