



A close-up photograph of a person's arm and shoulder. The person is wearing a dark-colored suit jacket over a white shirt. A gold ring is visible on their middle finger. The background is a plain, light color.

FAST FASHION SUPPLY CHAIN OPTIMIZATION

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PROBLEM STATEMENT

1. Rapid production cycles, low costs, changing consumer preferences.
 2. Challenges: inefficiencies, waste, and environmental impact.
 3. Goal: Optimize supply chain management by analyzing data to:
 - Identify bottlenecks.
 - Improve inventory management.
 - Enhance delivery efficiency.
-

UNDERSTANDING THE DATA

Dataset - Fast Fashion Supply Chain (Kaggle)

- Clothing Items:
 - 40 unique items with specified weights, selling prices, and target genders.
- Factory Data:
 - 5 factories with detailed production and manufacturing costs.
 - Each factory produces a variety of products with unique cost structures.
- Warehouse Details:
 - 20 warehouses receiving goods from factories.
 - Shipping details include costs, batch sizes, and delay risks.
- Statistical Insights:
 - Damaged production runs and seasonal sales trends.
 - Patterns highlighting inventory management challenges.
- Optimization Opportunity:
 - Data supports minimizing supply chain costs (transportation, holding, and penalties).
 - Helps in addressing demand-supply constraints effectively.



OUR GOAL

- Lower shipping costs.
- Reduce overstock and out-of-stock scenarios.
- Improve transportation and inventory efficiency.
- Lower environmental impact (transportation efficiency).

OPTIMIZATION PROBLEM 1

Fast Fashion Production Problem

Objective

Minimize production cost

P_{ij} : Production cost of product j at factory i .

x_{ij} : Number of units of product j produced at factory

I : Total number of factories.

J : Total number of products.

$$C = \sum_{i=1}^I \sum_{j=1}^J P_{ij} \cdot x_{ij}$$

Decision Variables

Units of products produced in each factory (4 factories \times 40 products = 160 variables).

x_{ij} : Number of units of product j produced at factory i

Constraints

Total production limit to the factory capacity constraint.

Non-negativity

$$\sum_{j=1}^J x_{ij} \leq \text{Factory Capacity}_i$$

MODEL 1: PRODUCTION COST

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2			Production Cost									
3				Product								
4			Factory	P001	P002	P003	P004	P005	P006	P007	P008	P009
5			F001		9.46	10.82	15.97	10.31	8.16	22.28	13.96	17.88
6			F002		6.45	6.42	17.64	18.72	6.42	27.71	9.43	12.40
7			F003		10.17	9.38	10.36	11.59	999.00	26.13	999.00	13.18
8			F005		11.06	15.86	10.96	999.00	9.47	10.94	7.58	13.57
9												
10				Production Constraints based on Log Data								
11			Demand		467,387	415,176	390,391	369,989	390,390	413,367	370,886	343,440
12												
13	Constraint											
14	Factory Capacity		Decision to Produce	Product								
15		Total to produce		P001	P002	P003	P004	P005	P006	P007	P008	P009
16	2,771,938	2,481,606	F001		-	-	-	369,989	390,390	-	-	-
17	2,015,871	2,015,871	F002		467,387	415,176	-	-	-	-	-	365,950
18	2,163,732	1,865,420	F003		-	-	390,391	-	-	-	343,440	-
19	3,109,846	804,685	F005		-	-	-	-	413,367	370,886	-	-
20		Total to produce		467,387	415,176	390,391	369,989	390,390	413,367	370,886	343,440	365,950
21		Selling Price		20	30	30	40	40	50	30	40	50
22												
23		Objective Function										
24		Maximizing the Profit		204,597,068.38								
25												
26												
27												
28												
29												
30												
31												
32												

Sensitivity Report 1 | **Production Solver** | Sensitivity Report 2 | Transshipment Solver | Products | Warehouse Shipping Costs | Production Costs | Log Data | + | Ready | Accessibility: Investigate | Grid View | Zoom In | Zoom Out | 140%

BLUE = PRODUCTION COST FROM DATASET

YELLOW = 1. DEMAND FROM LOG DATA 2. FACTORY CAPACITY FROM LOG DATA

GREEN = CALCULATED DECISION VARIABLES

SENSITIVITY REPORT ANALYSIS

	A	B	C	D	E	F	G	H
6	Variable Cells							
7	Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease	
9	\$D\$16	F001 P001	0	-0.519464482	10.54397694	0.519464482	1E+30	
10	\$E\$16	F001 P002	0	-1.914517136	19.18403539	1.914517136	1E+30	
11	\$F\$16	F001 P003	0	-5.607459747	14.03340236	5.607459747	1E+30	
12	\$G\$16	F001 P004	369989	0	29.69207353	1E+30	1.283313072	
13	\$H\$16	F001 P005	390390	0	31.84380956	1E+30	0.745257028	
14	\$I\$16	F001 P006	0	-11.34099385	27.7226059	11.34099385	1E+30	
15	\$J\$16	F001 P007	0	-6.382523924	16.03636388	6.382523924	1E+30	
16	\$K\$16	F001 P008	0	-4.706842066	22.11576128	4.706842066	1E+30	
17	\$L\$16	F001 P009	0	-2.886925051	33.8014523	2.886925051	1E+30	
18	\$M\$16	F001 P010	335945	0	59.69207353	1E+30	4.171408467	
19	\$N\$16	F001 P011	395961	0	63.96353897	1E+30	3.224799859	
20	\$O\$16	F001 P012	343516	0	23.95408713	1E+30	1.208431122	
21	\$P\$16	F001 P013	0	-2.301625088	16.79608254	2.301625088	1E+30	
22	\$Q\$16	F001 P014	0	-991.7082147	-984	991.7082147	1E+30	
23	\$R\$16	F001 P015	0	-0.519464482	10.54397694	0.519464482	1E+30	
24	\$S\$16	F001 P016	0	-7.932256216	13.16629631	7.932256216	1E+30	
25	\$T\$16	F001 P017	0	-2.126389855	17.51447226	2.126389855	1E+30	
26	\$U\$16	F001 P018	345404	0	29.69207353	1E+30	10.89576233	
27	\$V\$16	F001 P019	265896	0	31.84380956	1E+30	17.30145598	
28	\$W\$16	F001 P020	16817	0	43.95408713	1E+30	4.890487374	
29	\$X\$16	F001 P021	0	-7.926160634	16.03636388	7.926160634	1E+30	
30	\$Y\$16	F001 P022	0	-2.205921706	24.61668164	2.205921706	1E+30	
31	\$Z\$16	F001 P023	0	0	33.8014523	1E+30	9.94542804	
32	\$AA\$16	F001 P024	0	-10.4723741	36.60648297	10.4723741	1E+30	
33	\$AB\$16	F001 P025	0	-979.7387391	-919	979.7387391	1E+30	
34	\$AC\$16	F001 P026	0	-14.37304668	29.30775351	14.37304668	1E+30	
35	\$AD\$16	F001 P027	0	-983.2250224	-959	983.2250224	1E+30	
36	\$AE\$16	F001 P028	0	-4.082207844	16.99402142	4.082207844	1E+30	
37	\$AF\$16	F001 P029	0	-5.957733655	23.96426026	5.957733655	1E+30	
38	\$AG\$16	F001 P030	0	-12.57828536	28.01205347	12.57828536	1E+30	
39	\$AH\$16	F001 P031	0	-20.83170948	36.04144512	20.83170948	1E+30	
40	\$AI\$16	F001 P032	17688	0	22.85171862	1E+30	1.629590145	
41	\$AJ\$16	F001 P033	0	-6.099953118	16.79608254	6.099953118	1E+30	
42	\$AK\$16	F001 P034	0	-991.8261316	-984	991.8261316	1E+30	
43	\$AL\$16	F001 P035	0	-0.104973809	21.22716319	0.104973809	1E+30	
44	\$AM\$16	F001 P036	0	-0.774713673	6.657333445	0.774713673	1E+30	
45	\$AN\$16	F001 P037	0	0	20.1465047	1E+30	4.730790547	
46	\$AO\$16	F001 P038	0	-4.734632193	9.452613981	4.734632193	1E+30	
47	\$AP\$16	F001 P039	0	-4.627862895	14.76106165	4.627862895	1E+30	
48	\$AQ\$16	F001 P040	0	-5.006143967	11.46623452	5.006143967	1E+30	
49	\$D\$17	F002 P001	467387	0	13.54515007	1E+30	0.519464482	

CRITICAL VARIABLES:

- PO04, PO05, PO11, PO17 ARE KEY CONTRIBUTORS TO COST EFFICIENCY.
- HIGH REDUCED-COST VARIABLES (PO31, PO25) UNLIKELY TO IMPACT THE SOLUTION.

STABILITY:

- WIDE ALLOWABLE RANGES (1E+30) ENSURE SOLUTION STABILITY.

BOTTLENECKS:

- HIGH SHADOW PRICES HIGHLIGHT CAPACITY CONSTRAINTS IN KEY FACTORIES/PRODUCTS.

OPTIMIZATION MODEL 2

Fast Fashion Transshipment Problem

Objective

Minimize total supply costs (C), including:

- Transportation, holding, and penalty costs.
- Meet warehouse demand and respect factory limits.

Decision Variables

Units shipped from factories to warehouses (4 factories × 20 warehouses = 80 variables).

Included 40 Products as well in python to make $80 \times 40 = 3200$ Variables

Constraints

Supply, demand, non-negativity, inventory levels.

MODEL 2: TRANSSHIPMENT

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	U	V	W	
1		Given Info					Decision												
2		Source Fact	Warehouse	Shipping Cost (per 1000 pieces)			Source	▼	Warehouse	▼	Decision To Ship	▼							
3	F001	W001		1600			F001	W001		529721			Factory	Total Fact	Constraint				
4	F001	W002		4900			F001	W002		0			F001	2481606	=	2481606			
5	F001	W003		8000			F001	W003		0			F002	2015871	=	2015871			
6	F001	W004		3200			F001	W004		0			F003	1865420	=	1865420			
7	F001	W005		2933.333			F001	W005		0			F005	804685	=	804685			
8	F001	W006		800			F001	W006		548783									
9	F001	W007		4800			F001	W007		0				Warehouse Storage Limit	Total Fact	Constraint			
10	F001	W008		7200			F001	W008		0				W001	529721	<=	529721		
11	F001	W009		4000			F001	W009		0				W002	536115	<=	536115		
12	F001	W010		4400			F001	W010		0				W003	501030	<=	501030		
13	F001	W011		866.6667			F001	W011		577210					W004	0	<=	562589	
14	F001	W012		3200			F001	W012		0					W005	148506	<=	523957	
15	F001	W013		6400			F001	W013		0					W006	548783	<=	548783	
16	F001	W014		4083.333			F001	W014		0					W007	514786	<=	514786	
17	F001	W015		3200			F001	W015		0					W008	558164	<=	558164	
18	F001	W016		800			F001	W016		505668					W009	0	<=	544564	
19	F001	W017		2786.667			F001	W017		320224					W010	520730	<=	520730	
20	F001	W018		6300			F001	W018		0					W011	577210	<=	577210	
21	F001	W019		3200			F001	W019		0					W012	554147	<=	554147	
22	F001	W020		4000			F001	W020		0					W013	286934	<=	527861	
23	F002	W001		2916.667			F002	W001		0					W014	0	<=	562041	
24	F002	W002		412.5			F002	W002		0					W015	546272	<=	546272	
25	F002	W003		3750			F002	W003		0					W016	505668	<=	505668	
26	F002	W004		3300			F002	W004		0					W017	320224	<=	541412	
27	F002	W005		833.3333			F002	W005		0					W018	519292	<=	519292	
28	F002	W006		2062.5			F002	W006		0					W019	0	<=	552561	
29	F002	W007		387.5			F002	W007		0					W020	0	<=	547084	
30	F002	W008		2688			F002	W008		0									
31	F002	W009		3712.5			F002	W009		0									
32	F002	W010		825			F002	W010		0									
33	F002	W011		2062.5			F002	W011		0									
34	F002	W012		825			F002	W012		0									
35	F002	W013		2887.5			F002	W013		0									
36	F002	W014		3300			F002	W014		0									
37	F002	W015		825			F002	W015		0									
38	F002	W016		2500			F002	W016		0									
39	F002	W017		833.3333			F002	W017		0									
40	F002	W018		3333.333			F002	W018		0									
41	F002	W019		2960			F002	W019		0									
42	F002	W020		1020			F002	W020		0									
43	F003	W001		2950			F003	W001		0									
44	F003	W002		2360			F003	W002		0									
45	F003	W003		295			F003	W003		501030									

SENSITIVITY REPORT ANALYSIS

	A	B	C	D	E	F	G	H
5								
6	Variable Cells							
7	Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease	
8	\$I\$3	W001 Decision To Ship	529721	0	1.6	1.186666667	1E+30	
9	\$I\$4	W002 Decision To Ship	0	2.530833333	4.9	1E+30	2.530833333	
10	\$I\$5	W003 Decision To Ship	0	5.508333333	8	1E+30	5.508333333	
11	\$I\$6	W004 Decision To Ship	0	0.413333333	3.2	1E+30	0.413333333	
12	\$I\$7	W005 Decision To Ship	0	0.146666667	2.933333333	1E+30	0.146666667	
13	\$I\$8	W006 Decision To Ship	548783	0	0.8	1.986666667	1E+30	
14	\$I\$9	W007 Decision To Ship	0	2.455833333	4.8	1E+30	2.455833333	
15	\$I\$10	W008 Decision To Ship	0	4.708333333	7.2	1E+30	4.708333333	
16	\$I\$11	W009 Decision To Ship	0	1.213333333	4	1E+30	1.213333333	
17	\$I\$12	W010 Decision To Ship	0	1.618333333	4.4	1E+30	1.618333333	
18	\$I\$13	W011 Decision To Ship	577210	0	0.866666667	1.92	1E+30	
19	\$I\$14	W012 Decision To Ship	0	0.446904762	3.2	1E+30	0.446904762	
20	\$I\$15	W013 Decision To Ship	0	3.613333333	6.4	1E+30	3.613333333	
21	\$I\$16	W014 Decision To Ship	0	1.296666667	4.083333333	1E+30	1.296666667	
22	\$I\$17	W015 Decision To Ship	0	0.418333333	3.2	1E+30	0.418333333	
23	\$I\$18	W016 Decision To Ship	505668	0	0.8	1.986666667	1E+30	
24	\$I\$19	W017 Decision To Ship	320224	0	2.786666667	0.146666667	1.186666667	
25	\$I\$20	W018 Decision To Ship	0	3.808333333	6.3	1E+30	3.808333333	
26	\$I\$21	W019 Decision To Ship	0	0.413333333	3.2	1E+30	0.413333333	
27	\$I\$22	W020 Decision To Ship	0	1.213333333	4	1E+30	1.213333333	
28	\$I\$23	W001 Decision To Ship	0	3.273333333	2.916666667	1E+30	3.273333333	
29	\$I\$24	W002 Decision To Ship	536115	0	0.4125	0.4175	1E+30	
30	\$I\$25	W003 Decision To Ship	0	3.215	3.75	1E+30	3.215	
31	\$I\$26	W004 Decision To Ship	0	2.47	3.3	1E+30	2.47	
32	\$I\$27	W005 Decision To Ship	0	0.003333333	0.833333333	1E+30	0.003333333	
33	\$I\$28	W006 Decision To Ship	0	3.219166667	2.0625	1E+30	3.219166667	
34	\$I\$29	W007 Decision To Ship	514786	0	0.3875	0.4425	1E+30	
35	\$I\$30	W008 Decision To Ship	0	2.153	2.688	1E+30	2.153	
36	\$I\$31	W009 Decision To Ship	0	2.8825	3.7125	1E+30	2.8825	
37	\$I\$32	W010 Decision To Ship	520730	0	0.825	0.005	1E+30	
38	\$I\$33	W011 Decision To Ship	0	3.1525	2.0625	1E+30	3.1525	
39	\$I\$34	W012 Decision To Ship	0	0.028571429	0.825	1E+30	0.028571429	
40	\$I\$35	W013 Decision To Ship	0	2.0575	2.8875	1E+30	2.0575	
41	\$I\$36	W014 Decision To Ship	0	2.47	3.3	1E+30	2.47	
42	\$I\$37	W015 Decision To Ship	444240	0	0.825	0.003333333	0.005	
43	\$I\$38	W016 Decision To Ship	0	3.656666667	2.5	1E+30	3.656666667	
44	\$I\$39	W017 Decision To Ship	0	0.003333333	0.833333333	1E+30	0.003333333	
45	\$I\$40	W018 Decision To Ship	0	2.798333333	3.333333333	1E+30	2.798333333	
46	\$I\$41	W019 Decision To Ship	0	2.13	2.96	1E+30	2.13	
47	\$I\$42	W020 Decision To Ship	0	0.19	1.02	1E+30	0.19	
48	\$I\$43	W001 Decision To Ship	0	3.546666667	2.95	1E+30	3.546666667	

90	Constraints						
91	Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
92	\$L\$3	F001 Total Fact	2481606	2.786666667	2481606	221188	320224
93	\$L\$4	F002 Total Fact	2015871	0.83	2015871	102032	148506
94	\$L\$5	F003 Total Fact	1865420	0.59	1865420	240927	286934
95	\$L\$6	F005 Total Fact	804685	0.435	804685	375451	148506
96	\$L\$9	W001 Total Fact	529721	-1.186666667	529721	320224	221188
97	\$L\$10	W002 Total Fact	536115	-0.4175	536115	148506	102032
98	\$L\$11	W003 Total Fact	501030	-0.295	501030	286934	240927
99	\$L\$12	W004 Total Fact	0	0	562589	1E+30	562589
100	\$L\$13	W005 Total Fact	148506	0	523957	1E+30	375451
101	\$L\$14	W006 Total Fact	548783	-1.986666667	548783	320224	221188
102	\$L\$15	W007 Total Fact	514786	-0.4425	514786	148506	102032
103	\$L\$16	W008 Total Fact	558164	-0.295	558164	286934	240927
104	\$L\$17	W009 Total Fact	0	0	544564	1E+30	544564
105	\$L\$18	W010 Total Fact	520730	-0.005	520730	148506	102032
106	\$L\$19	W011 Total Fact	577210	-1.92	577210	320224	221188
107	\$L\$20	W012 Total Fact	554147	-0.033571429	554147	148506	375451
108	\$L\$21	W013 Total Fact	286934	0	527861	1E+30	240927
109	\$L\$22	W014 Total Fact	0	0	562041	1E+30	562041
110	\$L\$23	W015 Total Fact	546272	-0.005	546272	148506	102032
111	\$L\$24	W016 Total Fact	505668	-1.986666667	505668	320224	221188
112	\$L\$25	W017 Total Fact	320224	0	541412	1E+30	221188
113	\$L\$26	W018 Total Fact	519292	-0.295	519292	286934	240927
114	\$L\$27	W019 Total Fact	0	0	552561	1E+30	552561
115	\$L\$28	W020 Total Fact	0	0	547084	1E+30	547084

PYTHON FILE

BUSINESS RECOMMENDATIONS

- Expand Bottleneck Capacities:
 - Invest in factories and warehouses with high shadow prices.
 - Target capacity upgrades for high-demand products (P004, P011, P017).
- Utilize Surplus Resources:
 - Reallocate underutilized capacities from non-critical factories (F003, F005).
 - Balance the supply chain through flexible production and shipping.
- Optimize Transshipment:
 - Strengthen intermediate hubs to reduce direct shipping costs.
 - Focus on routes with high costs (P030, P032).
- Prepare for Cost Sensitivity:
 - Monitor cost-sensitive products (P011, P004, P006).
 - Develop contingency plans for demand surges and cost fluctuations.

CHALLENGES

Fast Fashion Supply Chain
Optimization

Decision Variable Limitations:

- Excel Solver insufficient for complex models (3,200 variables).
- Python provided flexibility and computational power.

Incomplete Data:

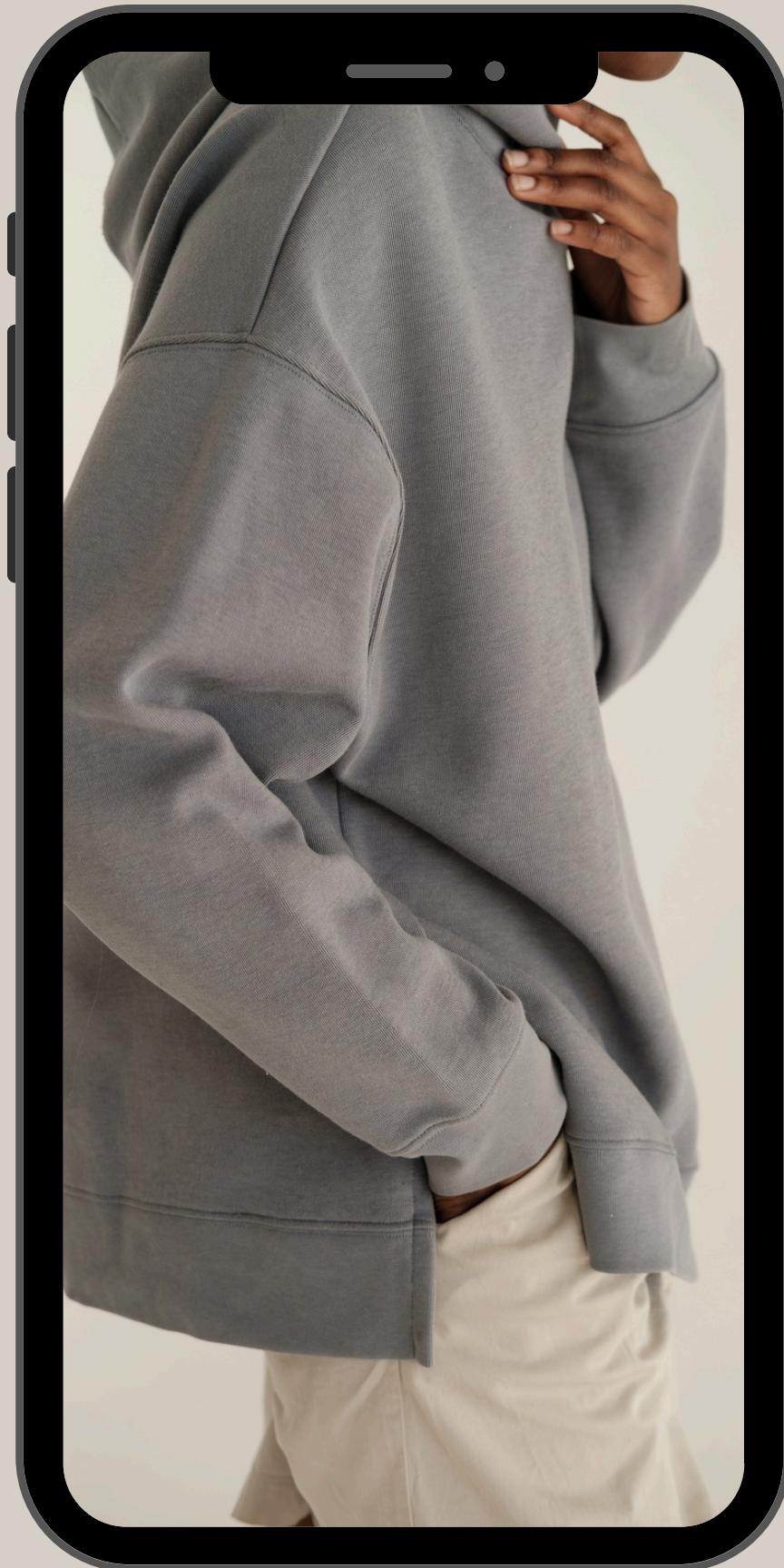
- Factory F004 excluded due to missing data.
- Demand was redistributed across remaining factories.

Data Integration and Complexity:

- Diverse datasets required significant preprocessing.
- Handling missing/inconsistent data critical for actionable results.

CONCLUSIONS

- Demonstrates effective application of optimization techniques.
- Balances profitability with sustainability.
- **Key takeaways:**
 - Long-term efficiency through bottleneck investments.
 - Align supply chain operations with environmental objectives.
 - Importance of preprocessing and Python for complex problems.



THANK YOU!
OPEN FOR Q/A
