



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)

1. Log Data
2. Production Costs
3. Products
4. Warehouse Shipping Costs

- 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.



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

Maximize the Profit

S_j : Selling price per unit of product j .

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

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

I : Total number of factories.

J : Total number of products.

$$\text{Profit} = \sum_{i=1}^I \sum_{j=1}^J (S_j \cdot x_{ij}) - \sum_{i=1}^I \sum_{j=1}^J (P_{ij} \cdot x_{ij})$$

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.

Production fulfills the demand for products.

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

$$\sum_{i=1}^I x_{ij} \geq D_j$$

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	365,950
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		Factory	Total Fact	Constraint			Objective Function		
3	F001	W001	1600				F001	W001	529721		F001	2481606	=	2481606				
4	F001	W002	4900				F001	W002	0		F002	2015871	=	2015871				
5	F001	W003	8000				F001	W003	0		F003	1865420	=	1865420				
6	F001	W004	3200				F001	W004	0		F005	804685	=	804685				
7	F001	W005	2933.333				F001	W005	0									
8	F001	W006	800				F001	W006	548783		Warehouse Storage Limit	Total Fact	Constraint					
9	F001	W007	4800				F001	W007	0		W001	529721	=	529721				
10	F001	W008	7200				F001	W008	0		W002	536115	=	536115				
11	F001	W009	4000				F001	W009	0		W003	501030	=	501030				
12	F001	W010	4400				F001	W010	0		W004	0	=	562589				
13	F001	W011	866.6667				F001	W011	577210		W005	148506	=	148506				
14	F001	W012	3200				F001	W012	0		W006	548783	=	548783				
15	F001	W013	6400				F001	W013	0		W007	514786	=	514786				
16	F001	W014	4083.333				F001	W014	0		W008	558164	=	558164				
17	F001	W015	3200				F001	W015	0		W009	0	=	544564				
18	F001	W016	800				F001	W016	505668		W010	520730	=	520730				
19	F001	W017	2786.667				F001	W017	320224		W011	577210	=	577210				
20	F001	W018	6300				F001	W018	0		W012	554147	=	554147				
21	F001	W019	3200				F001	W019	0		W013	286934	=	286934				
22	F001	W020	4000				F001	W020	0		W014	0	=	562041				
23	F002	W001	2916.667				F002	W001	0		W015	546272	=	546272				
24	F002	W002	412.5				F002	W002	536115		W016	505668	=	505668				
25	F002	W003	3750				F002	W003	0		W017	320224	=	320224				
26	F002	W004	3300				F002	W004	0		W018	519292	=	519292				
27	F002	W005	833.3333				F002	W005	0		W019	0	=	552561				
28	F002	W006	2062.5				F002	W006	0		W020	0	=	547084				
29	F002	W007	387.5				F002	W007	514786									
30	F002	W008	2688				F002	W008	0									
31	F002	W009	3712.5				F002	W009	0									
32	F002	W010	825				F002	W010	520730									
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	444240									
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	

VARIABLES

CRITICAL VARIABLES:

- ALMOST HALF THE WAREHOUSES ARE BEING USED AT FULL CAPACITY(EG. WAREHOUSE 1,6,11,16 ETC.) AND SOME OF THEM AT LOWER CAPACITY

STABILITY:

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

REDUCED COST:

- WAREHOUSES WITH HIGH REDUCED COSTS SUCH AS 3 AND 8 FAR FROM PROVIDING OPTIMAL SOLUTION
- WAREHOUSES OF LOW REDUCED COST SUCH AS 5 AND 12 CAN BE INCLUDED WITH SLIGHT COST REDUCTIONS

SENSITIVITY REPORT ANALYSIS

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

CONSTRAINTS

UTILIZATION:

- ALL FACTORIES ARE FULLY UTILIZED.
CONSTRAINT IS BINDING

SHADOW PRICE:

- FACTORY F001 HAS A HIGH SHADOW PRICE,
SHOWING IT IS VALUABLE TO EXPAND FOR
COST REDUCTION
- WAREHOUSES 4,9,14,19,20 ARE NOT
CONTRIBUTING TO OPTIMAL SOLUTION WITH
0 FINAL VALUE AND 0 SHADOW PRICE

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:**
 - Focus on product shipments with high costs (P030, P032).
- **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 was excluded due to missing data.

Data Integration and Complexity:

- Diverse datasets requires 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.
 - Need to monitor high-cost products/routes and associated demands.
- Importance of preprocessing and Python for complex problems.

THANK YOU!
OPEN FOR Q/A
