COMPREHENSIVE ANALYSIS OF SUPPLY CHAIN DATASET (POWER BI)

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I/ Introduction of dataset:

Here is a dataset collected from a Fashion and Beauty startup. The dataset is based on the supply chain of Makeup products. Link of this public dataset: https://www.kaggle.com/datasets/harshsingh2209/supply-chain-analysis

Below are all the features in the dataset (some assumptions are made to be easier for exploratory):

No	Column name	Data Type	Detail
1	Product Type	String	Product Type (Category)
2	SKU	String	Stock Keeping Unit
3	Price	Float	Price
4	Availability	Float	Availability (available stock in location)
5	Number of products sold	Float	Number of products sold
6	Revenue generated	Float	Revenue generated
7	Customer demographics	String	Customer demographics
8	Stock levels	Float	Stock at stock keeping center - storage warehouse (assume that it's on the way to location at the moment)
9	Lead times	Float	Number of days from order date to ready date of goods (supplier lead time)
10	Order quantities	Float	Order quantities (assume that it's on the way to location at the moment)
11	Shipping times	Float	Number of days for delivering finished goods to customer (shipping lead time)
12	Shipping carriers	String	Shipping carriers
13	Shipping costs	Float	Shipping costs
14	Supplier name	String	Supplier name
15	Location	String	Location
16	Lead time	Float	Number of days from shipping to arriving at our determined places (transportation lead time)
17	Production volumes	Float	Production volumes
18	Manufacturing lead time	Float	Number of days for manufacturing finished goods (manufacturing lead time)
19	Manufacturing costs	Float	Manufacturing costs
20	Inspection results	String	Inspection results
21	Defect rates	String	Defect rates (%) (assume that less than or equal to 2% is acceptable)
22	Transportation modes	String	Transportation modes
23	Routes	String	Routes
24	Costs	Float	Transportation costs

II/ Cleaning and transforming data in Power Query and Power BI:

1. Check if any duplicates or missing values:

⇨ Data is cleaned and ready to use.

2. Transform data:

2.1. Lead time:

- Unpivot 4 columns: [Lead times], [Shipping times], [Lead time], [Manufacturing lead time] into 2 columns: [Lead Time Description] and [Total Lead Time].
- Rename 4 distinct values of [Lead Time Description] as follows:
  "Lead times" => "Supplier LT"
  "Shipping times" => "Shipping LT"
  "Lead time" => "Transportation LT"
  "Manufacturing lead time" => "Manufacturing LT"

2.2. Costs:

- Unpivot 3 columns: [Shipping costs], [Manufacturing costs], [Costs] into 2 columns: [Cost Description] and [Cost].
- In column [Lead Time Description], rename "Costs" into "Transportation costs"

⇨ After transformation, we created dataset with 21 columns.

2.3. Margin:

- Create [Margin] column following this formula: [Margin] = ([Revenue generated] – [Cost])/ [Revenue generated]

2.4. Stock:

- Create [Total Stocks] column following this formula: [Total Stocks] = [Availability] + [Stock levels] + [Order Quantities]
- Create measure [Stock/Sales] = [Total Stocks] / [Revenue generated] => to check how many months the current stock can be sufficient for sales. Assume the ideal ratio is < 1, if this ratio is higher than 1 => overstock.

III/ Analyze data:

1. Sales analysis:

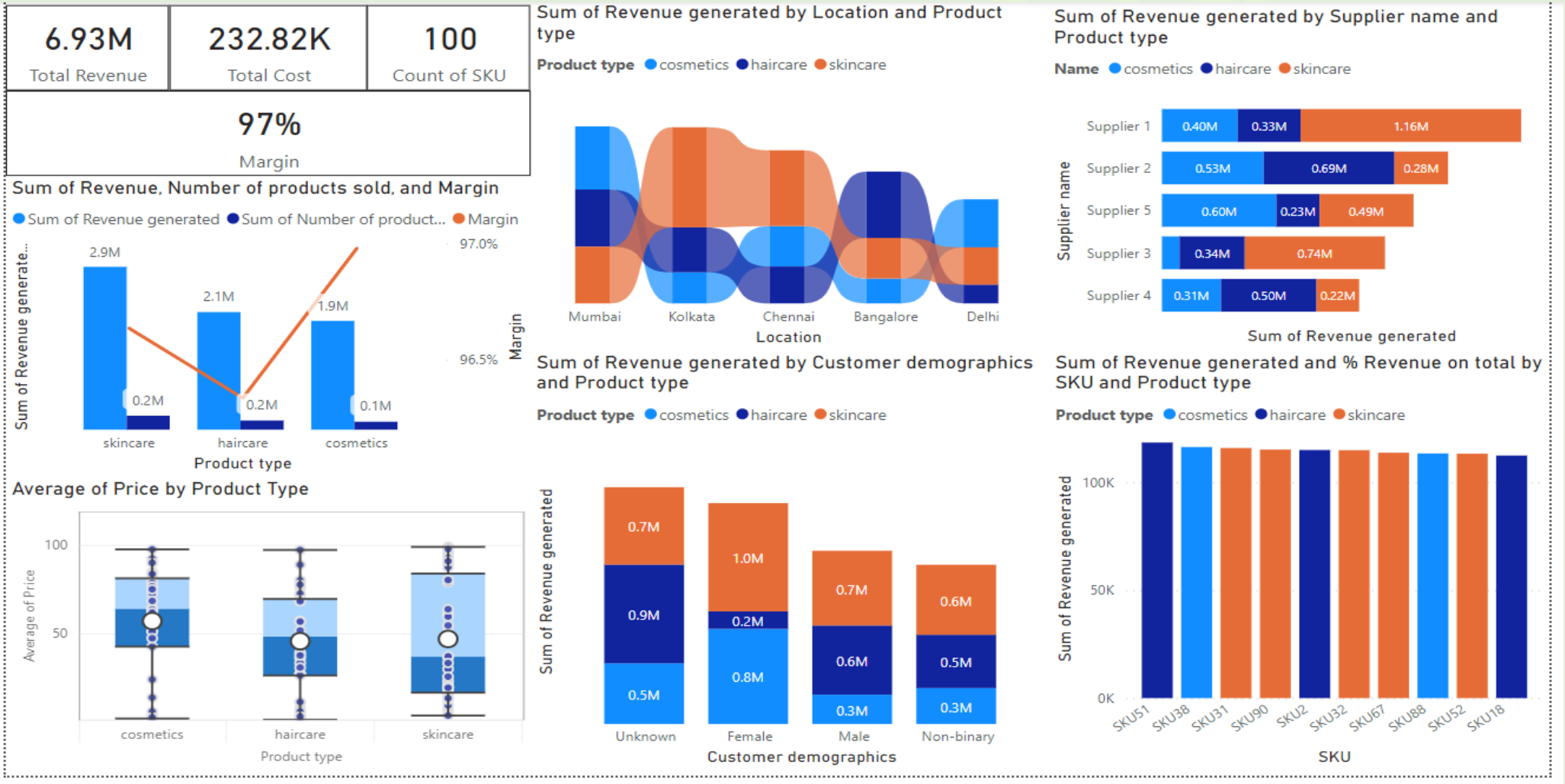
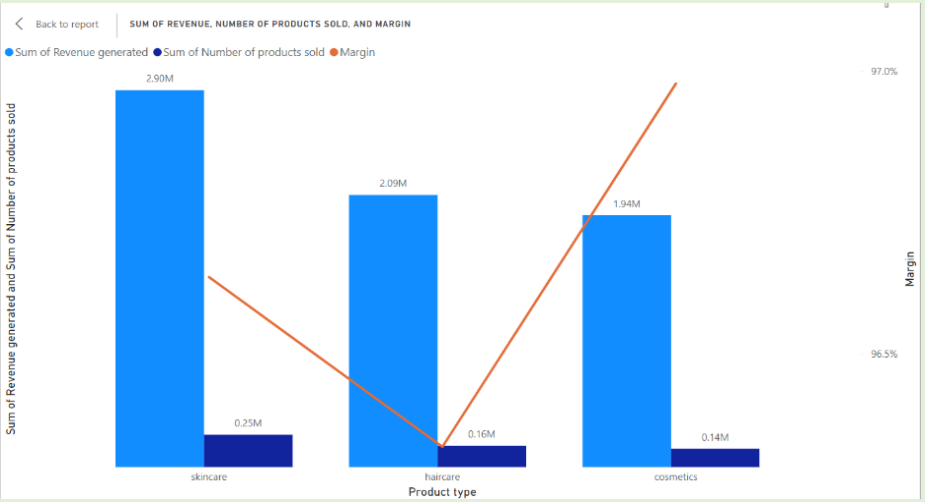


Figure 1 - Power BI Dashboard_Sales Analysis

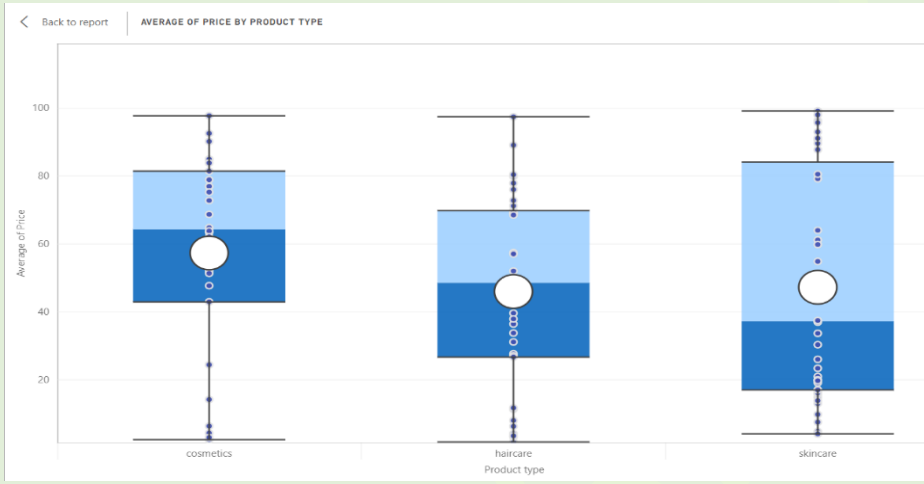
1.1. Sales by product type:



Skin care accounts for the largest sales with 2.9M, which is around 1.5 times higher than hair care (2.09M) and cosmetics (1.94M).

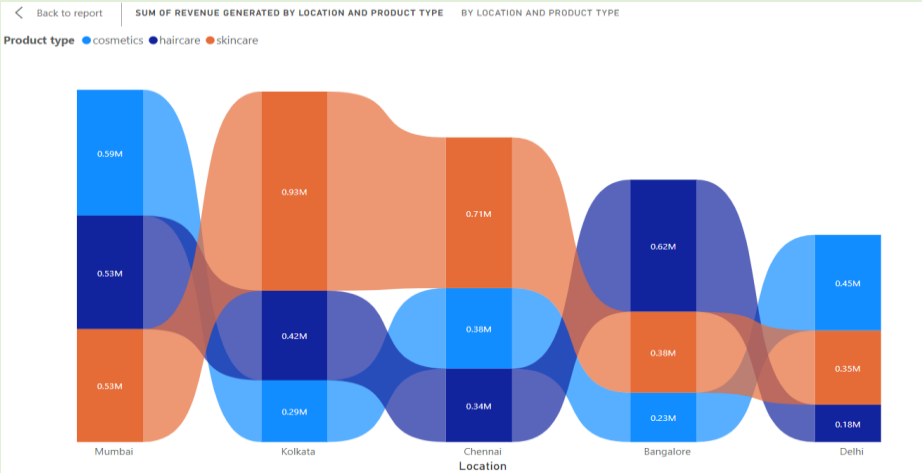
Number of product sold follows the same pattern as sales, which means skin care sell more quantity than others.

However, considering the margin, we can see that cosmetics bring the largest margin, the second place is skincare and haircare bring the least margin.



Checking the average price, we will see that cosmetics products are more expensive than others (57.36), following is haircare (46.01) and skincare (47.26). According to the graph of margin, there is a chance to believe that cosmetics' higher average price leads to the higher margin.

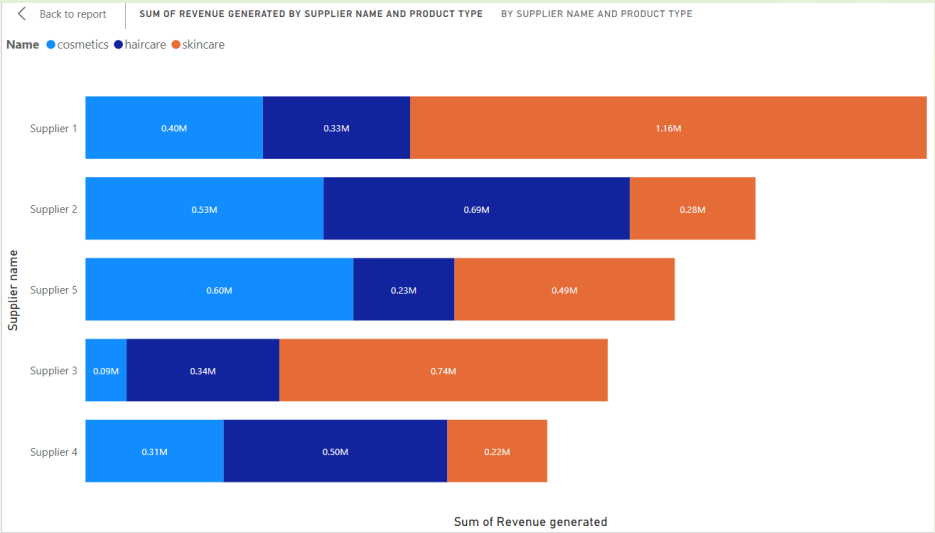
1.2. Sales by location:



Sales of Mumbai accounts for 1.65M, with highest sales comes from cosmetics. The second biggest sales is from Kolkata (1.63M), specialized in selling skincare (account for more than 50% of sales). Chennai is the third laggest sales location, with around 50% of sales come from skincare. Bangalore plays the 4th place, an important market of our haircare. And the last player is Delhi, with sales is 1.5 times less than Mumbai, and selling cosmetics the most.

Overall, we should take care of sales per product type especially in their big markets. For example, for skin care, we should try to maintain and expand sales at Kolkata, Chennai, and Mumbai. For haircare, Bangalore, Mumbai and Kolkata should be prioritized. For cosmetics, Mumbai and Delhi cannot be underestimated.

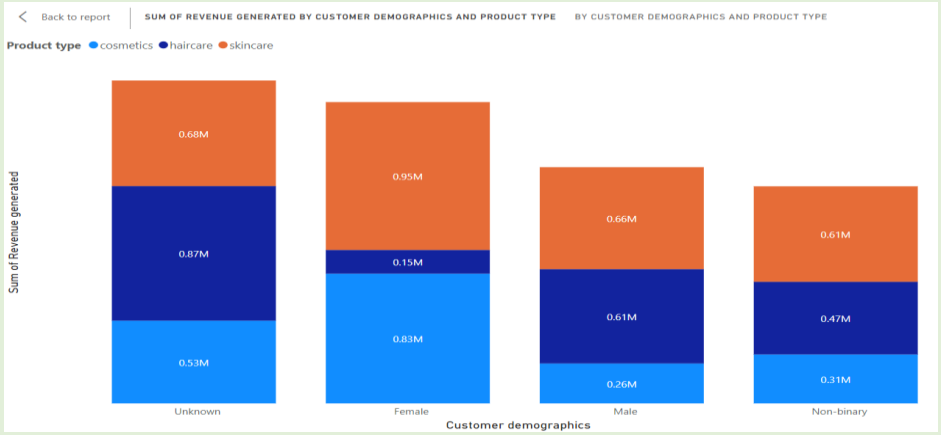
1.3. Sales by supplier:



Supplier 1 dedicates for the biggest sales (1.9M) with more than 50% comes from skincare. Supplier 2 is the second largest contributor that haircare sales account for mostly 50%. Supplier 5, 3 and 4 are following with bestselling product type respectively are cosmetics, skincare and hair care.

For cosmetics, sales come from Supplier 2 and 5 significantly. For haircare, Supplier 2 and 4 are dominated. And for skincare, Supplier 1 and 3 are the biggest contributors.

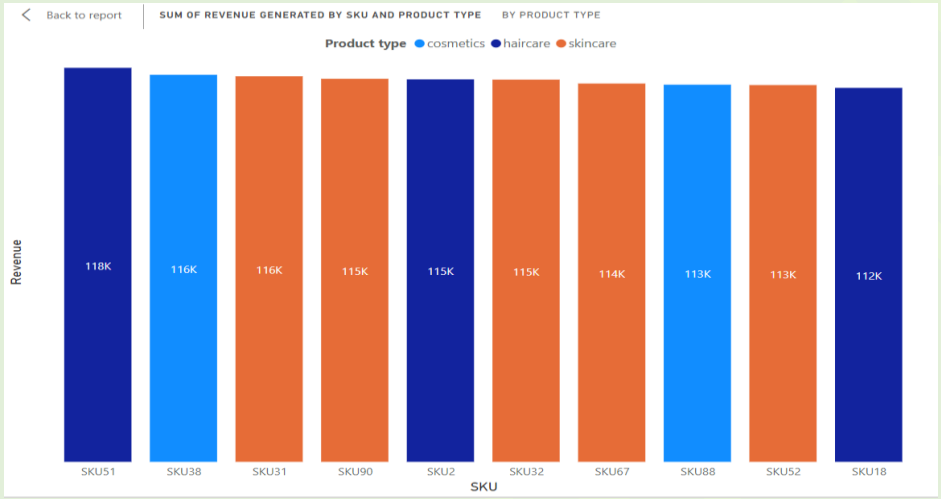
1.4. Sales by demographics:



Checking by customer demographics, we will see that sales come from unknown (seems like customers don't want to share or forget to update their gender) with 2.08M. The second place, female, buy our products 20% more than male, and non-binary customers account for the least sales.

Female customers prefer to buy skincare and cosmetics, while male don't use cosmetics that much so they buy skincare and haircare. Non-binary spend more money on buying skincare. Since unknown demographics don't give us clear information so we cannot analyze them.

1.5. Sales by SKU:



When spot top 10 bestselling SKUs, there are 5 out of 10 are within skincare category, then 3 SKUs come from haircare and the rest are cosmetics. Sales of top 10 is quite approximate to each other.

After looking through our sales, we can see that skincare plays an important role to generate sales, then follow by haircare and cosmetics. Average prices of cosmetics are higher than other product type, which brings higher margin but not the highest sales.

Our customers are mostly female (don't take into account the unknown group since it's unclear), following is male and non binary. Both customers' types prefer skincare, but the second favorite option of female is cosmetics, while haircare are preferred by male and non binary.

We also recognize that top 3 location brings most sales are Mumbai, Kolkata and Chennai. Each location will have different bestselling product type. While Kolkata and Chennai's customers prefer skincare, Bangalore is the biggest market for haircare, and for cosmetics, customers in Mumbai and Delhi are dominated.

Top 3 suppliers contributing for the highest sales are Supplier 1, 2, and 5. Sales of each product type(cosmetics, haircare, skincare) are contributed by Supplier 5, Supplier 2 and Supplier 1 respectively.

2. Supply chain – Cost analysis:

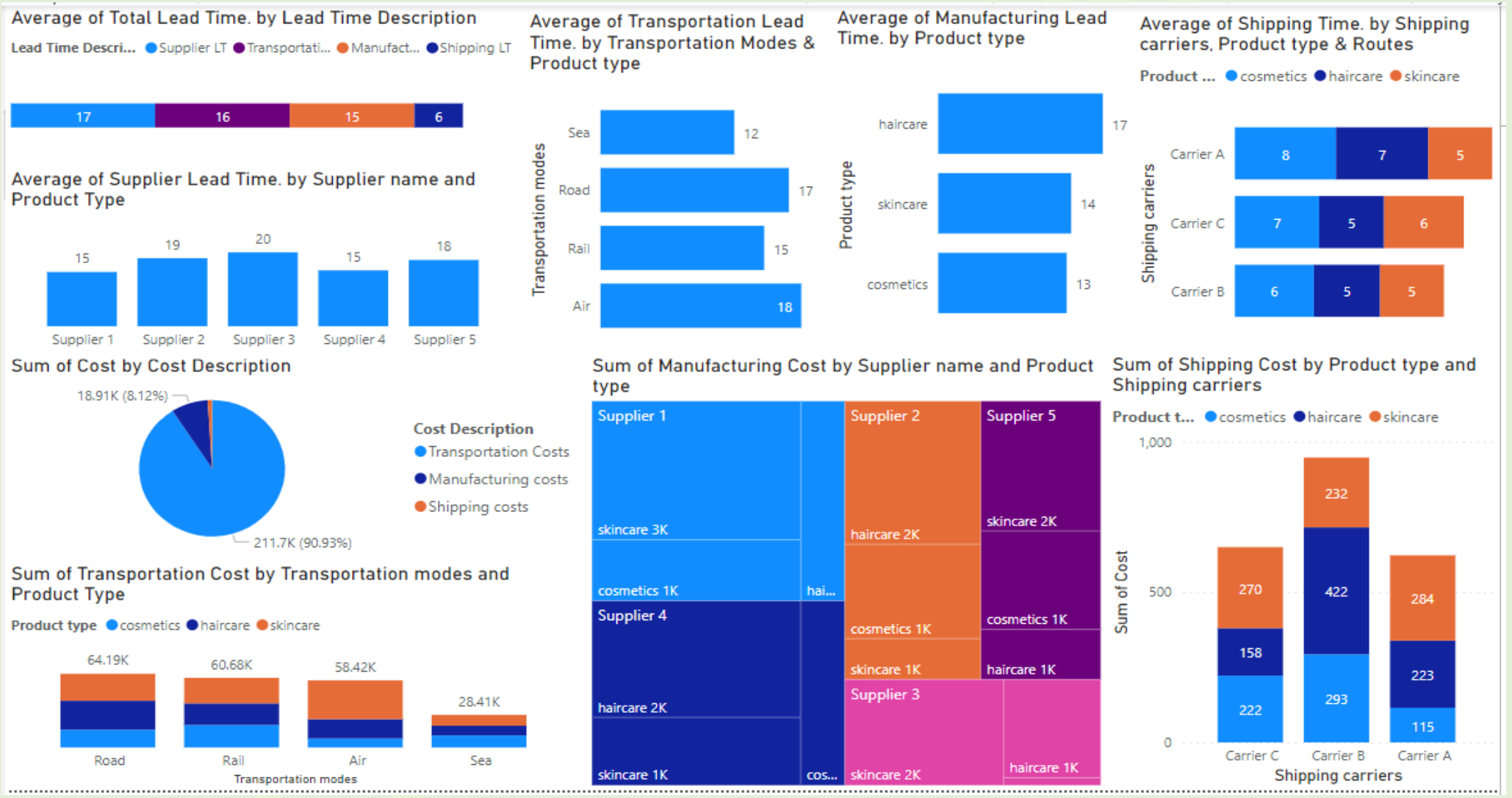
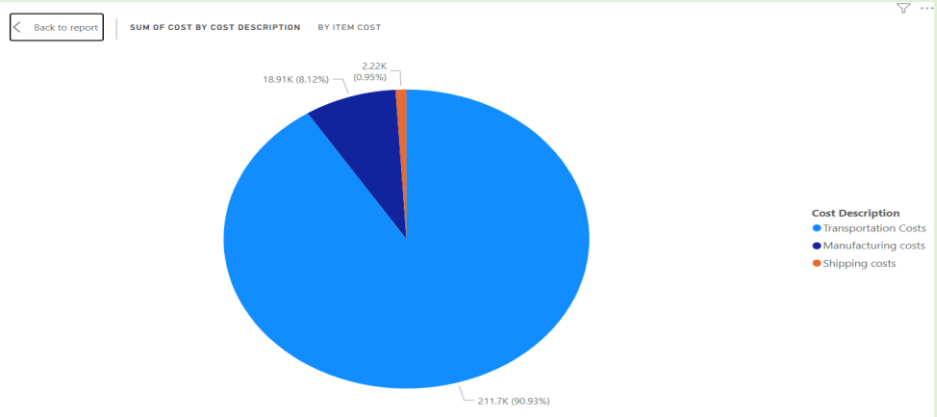


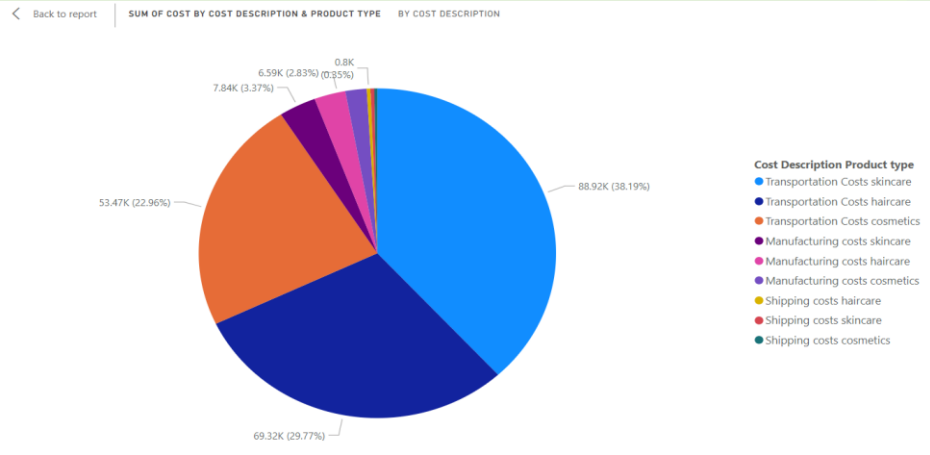
Figure 2 - Power BI Dashboard_Cost Analysis

2.1. Cost comparison:

a) Total cost overview:



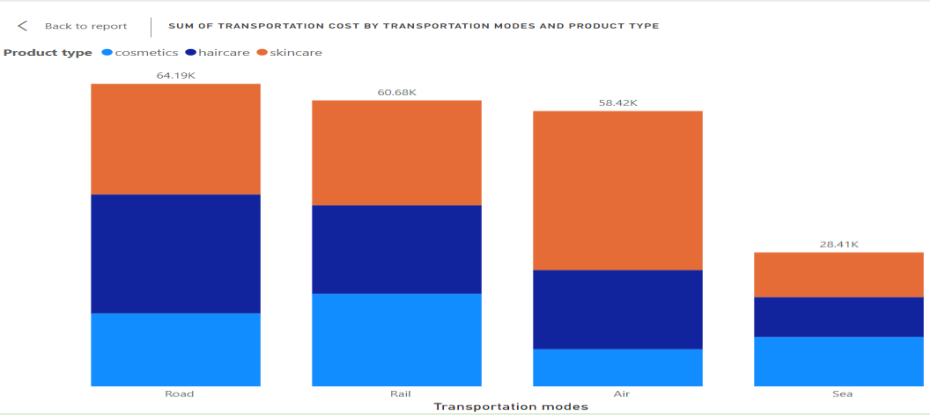
Total cost is dominated by Transportation costs, which account for 90.93%, more than 9 times larger than cost of Manufaturing (8.12%) and Shipping (0.95%).



Drilling down by Product Type, we can easily recognize that skincare assumes the most cost, then by haircare and cosmetics. It’s reasonable because it follows sales trend.

Let’s look into details of each cost!

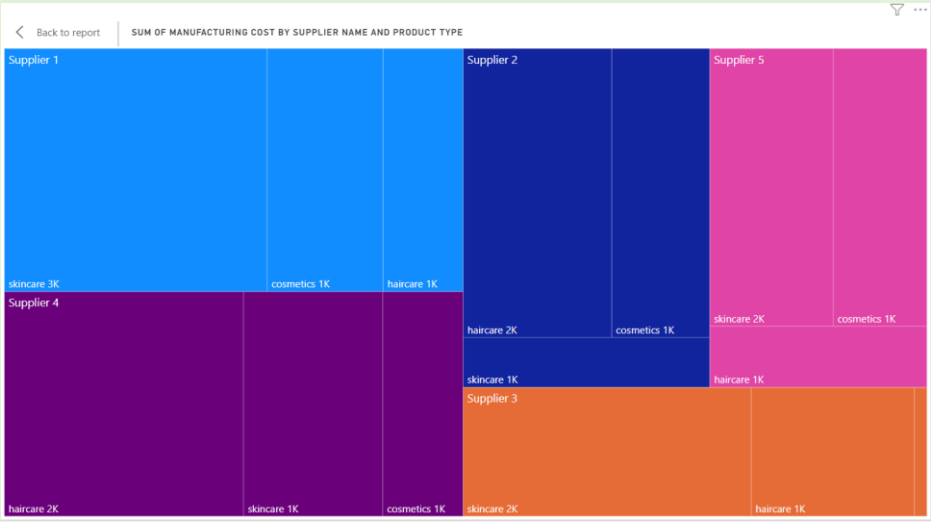
b) *Transportation cost:*



Rail is the most common transportation modes with total cost 64K. Rail and Air are following with total cost 60K and 58K. The least usage mode is Sea with only 28K.

For skin care products, we mostly transport by road and air. Road is also used to handle most of hair care products. For cosmetics, rail is the most favorite option.

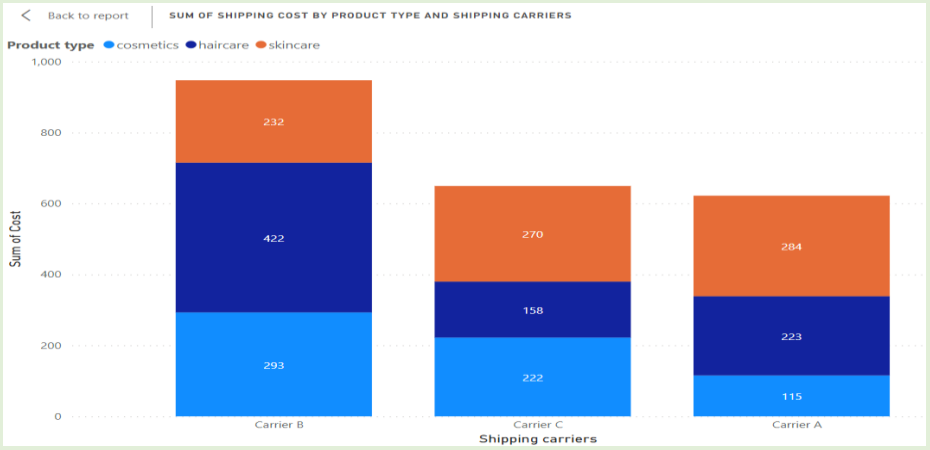
c) *Manufacturing cost:*



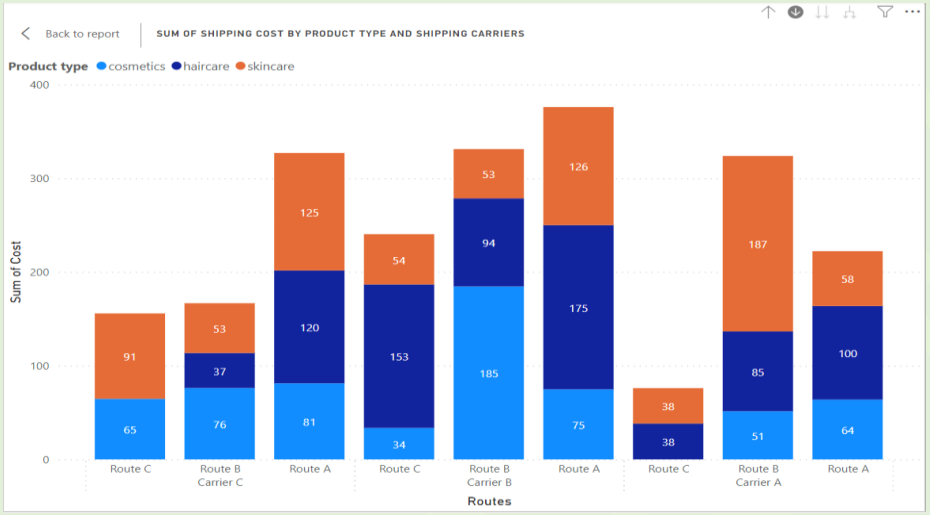
Each of our supplier can provide materials for both 3 product types. Supplier 1 supplies the most materials for manufacturing, especially for skin care products. Supplier 4 is the second biggest supplier whose materials used mostly for hair care. The 3rd place is supplier 2 with hair care materials. Supplier 5 and 3 are all specilized in skin care materials.

According to the treemap, we can see skin care products are manufactured the most, which shows the consistency with our sales where skin care products are dominated. Hair care and cosmetics are following.

d) Shipping cost:



Carrier B is chosen to handle the most shipments, they take care mostly of hair care products. Carrier C and Carrier A are the following options, which are all handling skin care the most, then cosmetics for Carrier C and hair care for Carrier A.

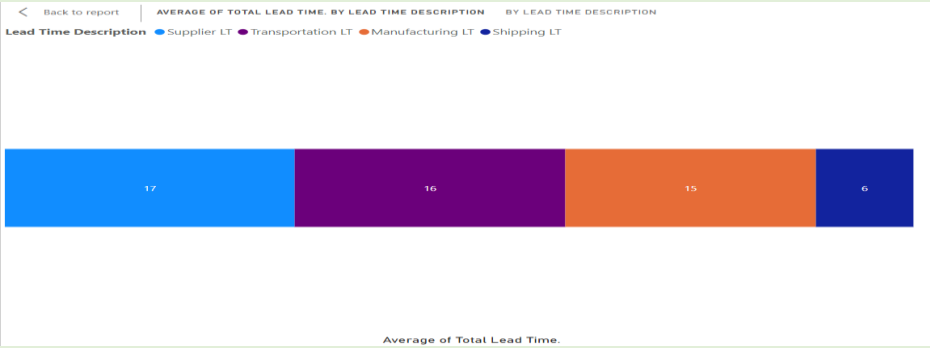


Drilling down by route, we will see that Carrier C and B use route A for shipping the most, while Carrier A prefer route B.

Now we know our company spend money on transportation the most and skincare products the most. Take a deeper look, for transportation, road transport assumes the biggest cost, for manufacturer we choose materials from Suplier 1 and Supplier 4 the most, for delivery Carrier B is dominated. But the reason why we spend money on them higher than others, let's take a look at their lead time to see if it's really effective than others.

2.2. Lead time comparison:

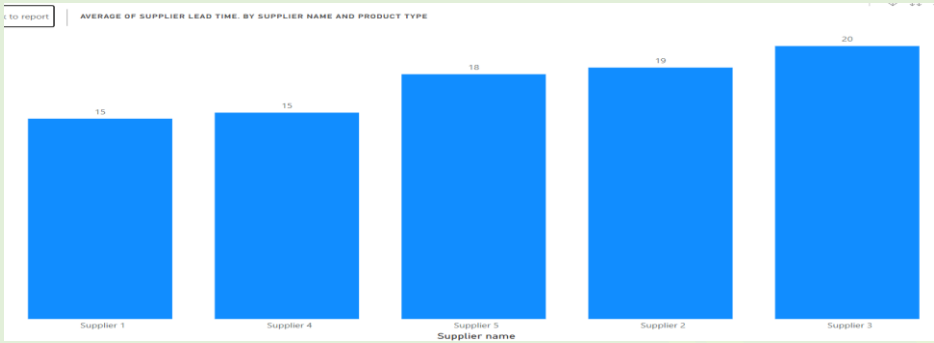
a) Lead time overview:



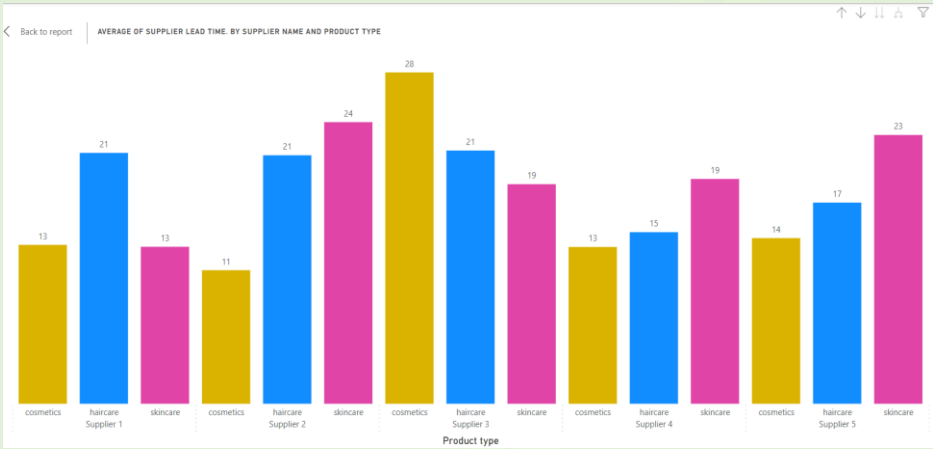
Let's resume the whole process by looking into lead time. The process start from when we place order with the supplier, then they need time to process our order (supplier lead time). When goods are ready, it's time for transportation (transportation lead time). Then our factory receives materials and works on production (manufacturing lead time). The last step, when we've done finished goods, we will ship them to the customers by using shipping carriers' services.

Generally, average time for all steps is 44 days.

b) Supplier lead time:



Now it makes sense that the company favors supplier 1 and 4 thanks to their short lead time. Supplier 3 with longest least time definitely become the least favorite option.



Take a deeper look to see lead time of each type by supplier. Supplier 1 mostly supply skin care and less supplies on hair care, now we know it's positively related to their lead time.

Similarly for supplier 3, skin care with shortest lead time are bought more often, while cosmetics with really long lead time are not in favor.

However, for supplier 4 and 5, we buy material not based on lead time (we should check for other reasons).

For supplier 2, lead time of skin care is longest so we don't buy more often. But lead time of cosmetics is short and we don't buy a lot (we should check for other reasons).

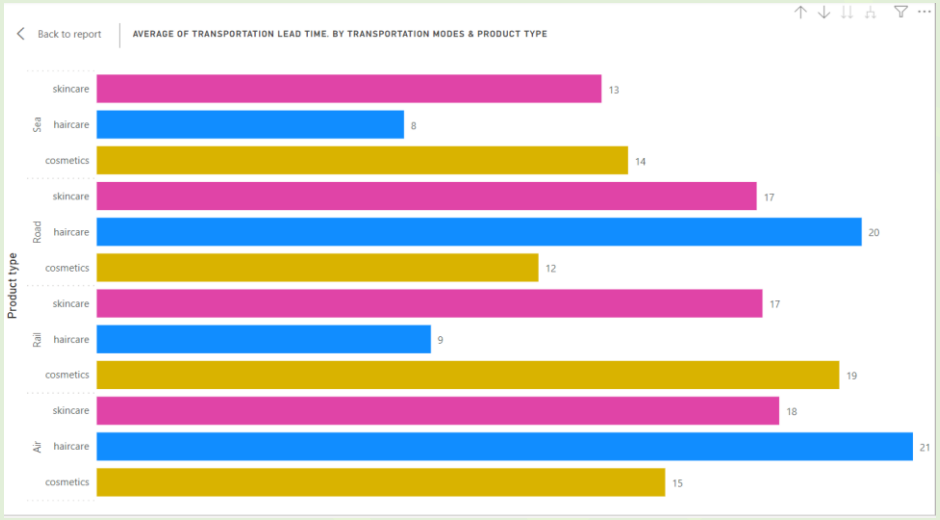
When make comparison by product type, we see skin care and hair care are supplied respectively by supplier 1 and supplier 4 due to their shortest lead time. Similarly, cosmetics are bought from supplier 1 and 2 because of their short lead time.

c) Transportation lead time:

It seems strange when lead time of air freight is the longest and sea is the shortest and the company use sea freight the least.

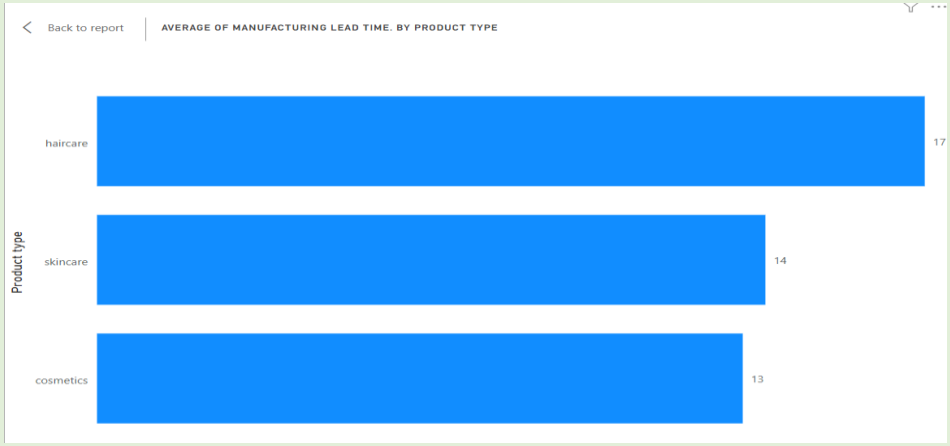
Anyway, we will assume that even though sea freight with shorter lead time but it requires large volume to process, while our shipments are smaller and suitable for other transportation modes.

Let's check each type of product's lead time by transportation mode



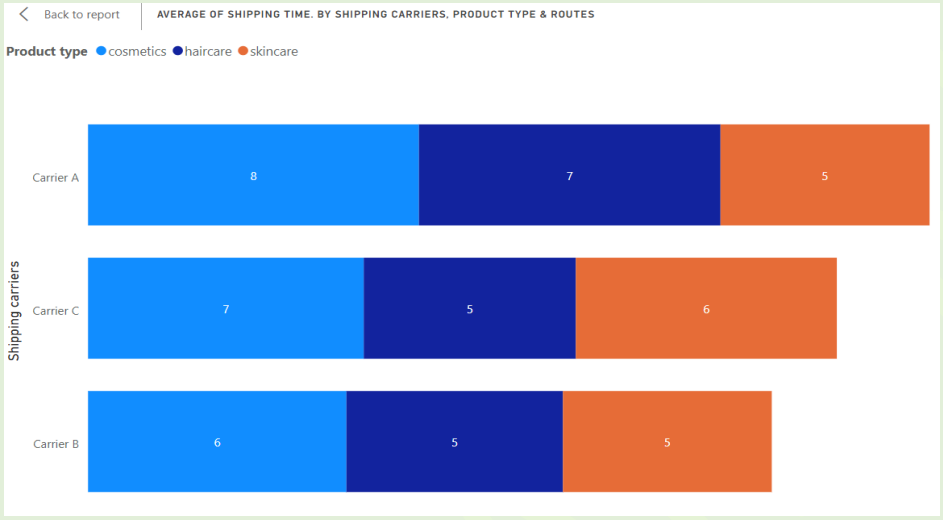
According to the graph, we can see our company don't choose transportation mode for each type of product based on lead time, perhaps we consider the average price instead.

d) Manufacturing lead time:



Now we know producing hair care products takes more days than other types of products. We should remember this for production planning later on.

e) Shipping lead time:

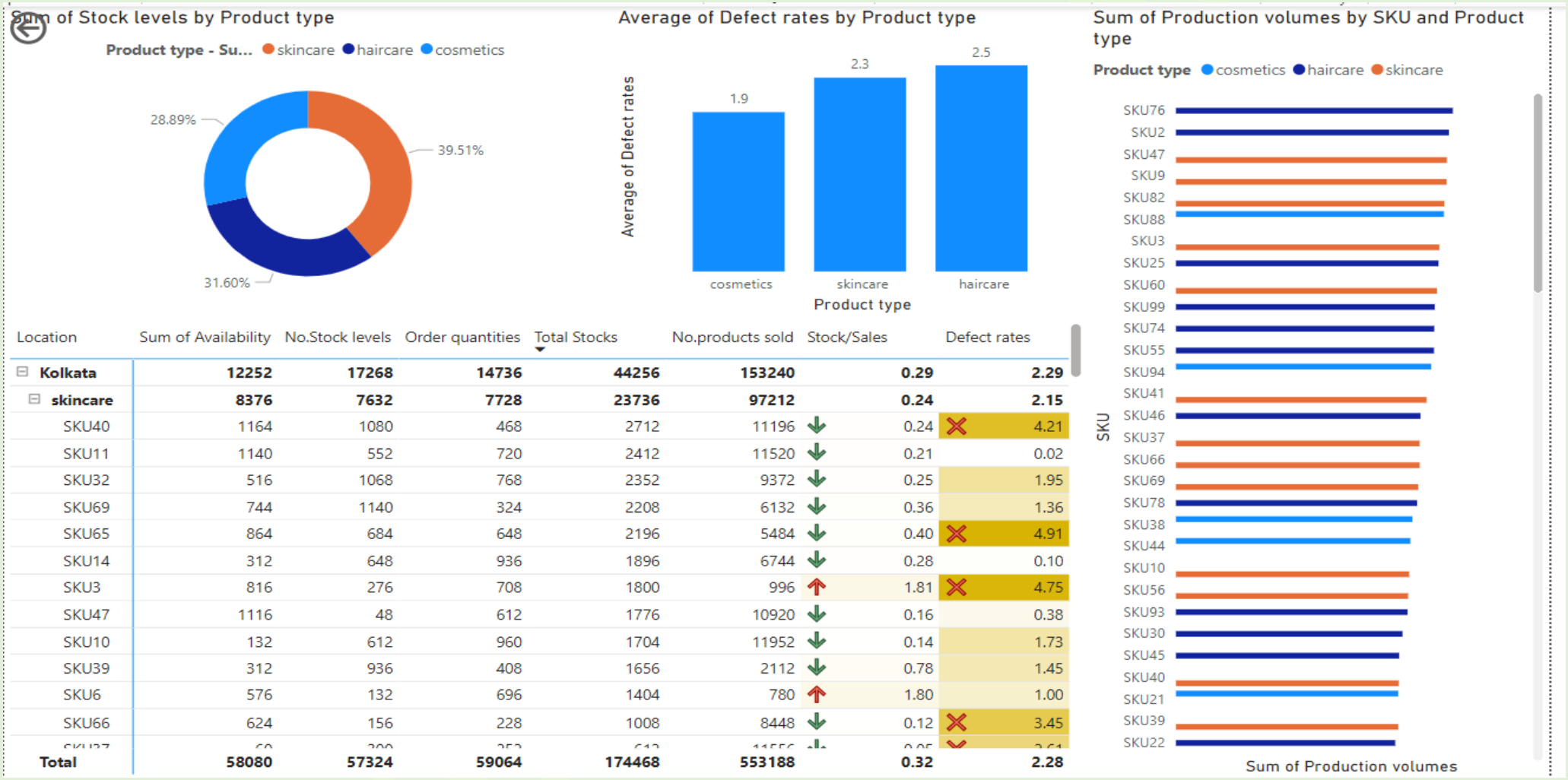


It's understandable to use most shipping service of Carrier B due to their lead time efficiency, especially for their hair care products.

Carrier C and Carrier A, similarly, are chosen to ship skin care because of their short lead time. However, we still need to consider other factors such as average price to understand the reason for this decision making.

In conclusion, we cannot see a strong relationship between lead time and cost. Perhaps there are other factors affecting our decision-making of spending money (such as unit price from supplier, freight quotation from carrier/transportation mode, etc).

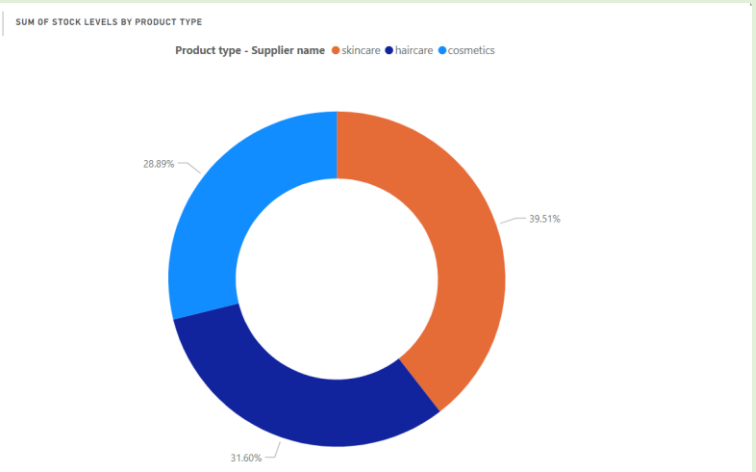
3. Stock analysis:



Location	Sum of Availability	No.Stock levels	Order quantities	Total Stocks	No.products sold	Stock/Sales	Defect rates
Kolkata	**12252**	**17268**	**14736**	**44256**	**153240**	**0.29**	**2.29**
skincare	**8376**	**7632**	**7728**	**23736**	**97212**	**0.24**	**2.15**
SKU40	1164	1080	468	2712	11196	0.24	4.21
SKU11	1140	552	720	2412	11520	0.21	0.02
SKU32	516	1068	768	2352	9372	0.25	1.95
SKU69	744	1140	324	2208	6132	0.36	1.36
SKU65	864	684	648	2196	5484	0.40	4.91
SKU14	312	648	936	1896	6744	0.28	0.10
SKU3	816	276	708	1800	996	1.81	4.75
SKU47	1116	48	612	1776	10920	0.16	0.38
SKU10	132	612	960	1704	11952	0.14	1.73
SKU39	312	936	408	1656	2112	0.78	1.45
SKU6	576	132	696	1404	780	1.80	1.00
SKU66	624	156	228	1008	8448	0.12	3.45
Total	**58080**	**57324**	**59064**	**174468**	**553188**	**0.32**	**2.28**

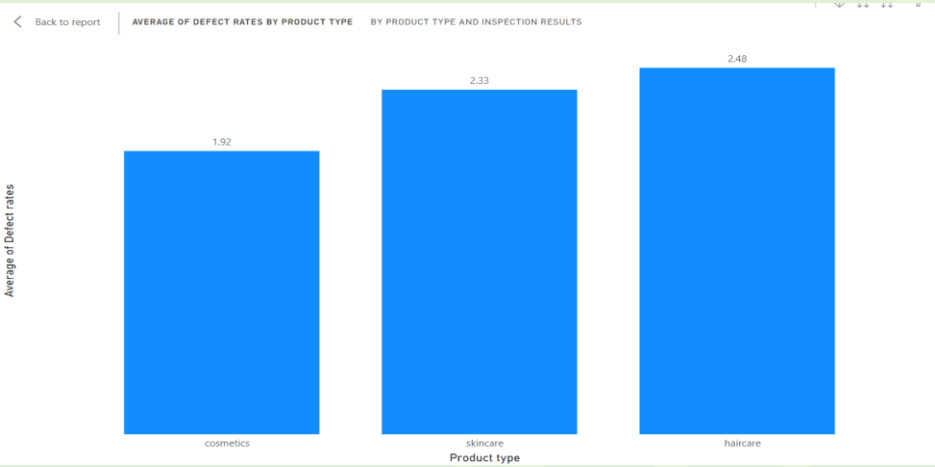
Figure 3 - Power BI Dashboard_Stock Analysis

3.1. Stock by product type:



Definitely, the total stocks of skincare is more than other types (39.51%) because they generate the most sales. Haircare accounts for 31.6% and the rest is cosmetics with 28.89%.

3.2. Defect rate by product type:



Taking into consideration the defect rate, we can see cosmetics has the smallest defect rate (1.9%) and haircare has largest defect rate (2.48%). We should make deeper analysis to see what cause the higher defective products for haircare and propose solution.

3.3. Stock by location, product type and SKU:

Location	Sum of Availability	No.Stock levels	Order quantities	Total Stocks	No.products sold	Stock/Sales	Defect rates
Kolkata	12252	17268	14736	44256	153240	0.29	2.29
Chennai	13152	9588	13308	36048	105216	0.34	2.64
Mumbai	11640	11184	12996	35820	113112	0.32	2.12
Bangalore	12144	10272	9228	31644	65040	0.49	2.09
Delhi	8892	9012	8796	26700	116580	0.23	2.23
Total	**58080**	**57324**	**59064**	**174468**	**553188**	**0.32**	**2.28**

When we check stocks by location, we can see that Kolkata has the most stocks, which is more than 1.5 times higher than stock of Delhi. Overall, the Stock/Sales of all locations are met with our expectation (less than 1). However, the defect rates of all location are higher than 2, which should be decreased.

Location	Sum of Availability	No.Stock levels	Order quantities	Total Stocks	No.products sold	Stock/Sales	Defect rates
Kolkata	**12252**	**17268**	**14736**	**44256**	**153240**	**0.29**	**2.29**
skincare	8376	7632	7728	23736	97212	0.24	2.15
haircare	3000	5808	5220	14028	40884	0.34	2.71
cosmetics	876	3828	1788	6492	15144	0.43	1.89
Chennai	**13152**	**9588**	**13308**	**36048**	**105216**	**0.34**	**2.64**
skincare	5556	3216	5664	14436	56448	0.26	2.58
haircare	3648	4572	3816	12036	27852	0.43	3.32
cosmetics	3948	1800	3828	9576	20916	0.46	1.93
Mumbai	**11640**	**11184**	**12996**	**35820**	**113112**	**0.32**	**2.12**
cosmetics	5124	5664	4272	15060	38496	0.39	1.73
skincare	2988	3228	4416	10632	37212	0.29	2.47
haircare	3528	2292	4308	10128	37404	0.27	2.22
Bangalore	**12144**	**10272**	**9228**	**31644**	**65040**	**0.49**	**2.09**
haircare	5628	4764	3564	13956	25920	0.54	1.92
skincare	4584	2796	4296	11676	20628	0.57	2.45
cosmetics	1932	2712	1368	6012	18492	0.33	1.90
Delhi	**8892**	**9012**	**8796**	**26700**	**116580**	**0.23**	**2.23**
cosmetics	4104	4296	4860	13260	48036	0.28	2.20
skincare	2940	2424	3084	8448	37272	0.23	2.05
haircare	1848	2292	852	4992	31272	0.16	2.50
Total	**58080**	**57324**	**59064**	**174468**	**553188**	**0.32**	**2.28**

Location	Sum of Availability	No.Stock levels	Order quantities	Total Stocks	No.products sold	Stock/Sales	Defect rates
Kolkata	**12252**	**17268**	**14736**	**44256**	**153240**	**0.29**	**2.29**
skincare	**8376**	**7632**	**7728**	**23736**	**97212**	**0.24**	**2.15**
SKU40	1164	1080	468	2712	11196	0.24	4.21
SKU11	1140	552	720	2412	11520	0.21	0.02
SKU32	516	1068	768	2352	9372	0.25	1.95
SKU69	744	1140	324	2208	6132	0.36	1.36
SKU65	864	684	648	2196	5484	0.40	4.91
SKU14	312	648	936	1896	6744	0.28	0.10
SKU3	816	276	708	1800	996	1.81	4.75
SKU47	1116	48	612	1776	10920	0.16	0.38
SKU10	132	612	960	1704	11952	0.14	1.73
SKU39	312	936	408	1656	2112	0.78	1.45
SKU6	576	132	696	1404	780	1.80	1.00
SKU66	624	156	228	1008	8448	0.12	3.45
SKU37	60	300	252	612	11556	0.05	2.61
haircare	**3000**	**5808**	**5220**	**14028**	**40884**	**0.34**	**2.71**
SKU12	492	1200	1020	2712	4032	0.67	2.16
SKU25	876	984	624	2484	1704	1.46	3.80
SKU22	660	852	756	2268	10608	0.21	2.59
SKU77	168	1152	684	2004	4308	0.47	3.06
Total	**58080**	**57324**	**59064**	**174468**	**553188**	**0.32**	**2.28**

Expand the stock into location and product type, we can see the stocks still look nice.

But when we expand one more hierachy into SKU, there are some of them are overstock. For example, in Kolkata, for skincare, there are 2 SKUs: SKU3 and SKU6 with Stock/Sales higher than 1, which means it's overstock and need to be cleared soon. Similarly, we can check in other locations and product types to take actions.

To summarize, skincare is our top sales so their stocks accounts for 39.51% at the moment.

The defect rate of cosmetics meet our requirement but for other types, the defect rates are still high and need to be improved.

Kolkata and Chennai have the largest stock, Delhi with the least sales has smallest stock. The Stock/Sales of all location seems nice but when break down into SKUs, there are some of them are much more than usual so we need to find solution for clear them out soon (by allocating to other location/running promotions).

IV/ Next steps:

- Check whether or not the high price and high margin of cosmetics affect its sales.
- Compare the current sales/cost/stock versus same period last year sales/cost/stock.
- Compare the average prices by product type among 5 suppliers to decide if any changes should be made in buying decision for cost efficiency.
- Compare the freight quotations among carriers as well as transportation modes to decide if any changes should be made for cost efficiency.
- Find the reasons why defect rates are high and propose solutions for improvement.
- Compare the current lead time versus expected lead time to see if any improvements should be made.