SEMINAR REPORT

Supplier Selection using AHP-TOPSIS

ANARANYA CHAKRABORTY

ROLL- 2022UGPI042

PRODUCTION & INDUSTRIAL ENGINEERING

NIT JAMSHEDPUR

UNDER THE GUIDANCE OF DR. BIJAN SARKAR

ACKNOWLEDGEMENT

I would like to extend my sincere gratitude to Dr. Bijan Sarkar, whose expert guidance and unwavering support made this project possible. Your insightful feedback, patient mentorship, and encouragement helped me navigate each stage of the analysis with confidence and clarity. I also thank the faculty of Production and Industrial engineering Department for providing the resources and constructive environment that fostered my learning. Finally, I extend my appreciation to my peers for their valuable discussions and to my family for their constant encouragement. This work reflects the collective effort and dedication of everyone who contributed to its success.

CONTENTS

ABSTRACT

During the ***COVID-19*** pandemic, retail supply chains around the world faced serious challenges—empty shelves, unpredictable demand swings, and concerns about employee safety. In my project, I set out to understand these challenges and build a straightforward way for supply chain teams to decide what to tackle first.

Methods *:* I started by talking to experts and reviewing recent studies to pick out eleven common problems, from balancing supply and demand to making sure warehouse staff stay safe. Then, I used the Analytic Hierarchy Process ***(AHP)*** to compare and score seven key factors—like how viable a solution is, how well it keeps products moving, and how it affects trust between suppliers and customers. With those weights in hand, I applied the ***TOPSIS*** method to rank each problem by its overall "distance" from an ideal fix.

Result : The results showed that keeping supply and demand in sync is the top priority (about 27.5%), followed closely by employee safety (26.5%) and reliable transport (16.5%). This simple AHP–TOPSIS framework gives retail supply chain managers a clear, data-backed path to stronger, more efficient operations.

Key findings : Among all problems, *Consumer attitude, Lack of access, Absence of government funding, Communication problems, Lack of security and safety, Maintenance of an appropriate balance among supply* and demand are identified as the prime most common concerns for retailers in supply chain management during this time.

INTRODUCTION

In late 2019, a pneumonia of unidentified was discovered in Wuhan, China, and was named COVID-19. Later in March 2020 WHO declared it a pandemic. It became necessary to practice isolation and social distancing. Nations implemented travel bans, proclaimed nation-wide lockdown and restricted citizen mobility.

Thus sudden **hike** and **fall** of requirement of items were seen. it presented an uncertainty in the work force with workers returning to hometown for safety. Distribution centres became unavailable thus disrupting the whole supply chain Disruptions occurred in seven-dimensional analysis *(**geography, scale, goods and service availability, individual attitude, monetary sector, time and event***). In addition technology issues and unstable availability of resources created a state of panic for a prolonged period, spread with unpredictability and negative impact on logistical infrastructure.

Traders and dealers are an integral part of the SC and were under a lot of pressure to deliver necessary products. Due to shifting, they faced ***capacity limits and excess demand issues***. In my project I have emphasised on estimation of problems exerted on retailers, identifying key problems in India. The prime objectives of the project include:

- ***Selection*** and ***categorization*** of criterions impacting SC functioning.
- ***Identification*** and ***classification*** of supply chain problems impacting suppliers.
- Transforming expert reviews to develop comparison matrix for ***MCDM*** calculations.
- ***Weightage*** calculation by AHP method.
- Calculation of ***performance score*** of challenges and prioritizing them on basis of rank.

LITERATURE REVIEW

In this project of assessment of challenges in supply chain among retailers during COVID-19 epidemic we look forward to identify, compare and rank the challenges best to worst based on performance score.

Generally identification of problems encountered by suppliers has been performed without assigning weights to each problem. Furthermore, each criterion had been given equal weightage. But ideally some criterions have larger impact than others thus providing ineffective solutions. Thus to make the research more accurate, reliable and precise I have used AHP-TOPSIS based hybrid MCDM method to assign different weights to multiple criterions, signifying its relative impact compared to other criterions IS the novelty of my project.

MCDM : *Multi-Criteria Decision Making* is a set of methods for evaluating options against multiple, often conflicting, criteria. In this project, MCDM provides the overall framework to rank supply chain problems by combining different performance factors into a single decision sequence.

AHP *: The Analytic Hierarchy Process* structures complex decisions into a hierarchy of goals, criteria, and alternatives. Here, AHP was used to compare seven performance criteria pairwise, converting expert judgments into numerical weights. These weights reflect each criterion's relative importance in prioritizing supply chain challenges.

TOPSIS : *Technique for Order Preference by Similarity to Ideal Solution* ranks alternatives by measuring their distance from the best and worst hypothetical solutions. In this study, after weighting criteria with AHP, TOPSIS calculated each problem's "***closeness" to an ideal solution".*** The resulting performance scores directly determined which supply chain issues is to be addressed first.

PROBLEM IDENTIFICATION

The supply chain challenges are expensive and detrimental in the long run. We majorly emphasize on the disorder as a result of the pandemic in the distribution chain. SC sited operation issues including "*absence of economic cooperation*" and "*cost-sharing agreements*". It also faced "trust difficulties" among participants, "lack of remuneration" and "*dearth of an effective data sharing structure*". Pandemic breakouts creates damage in demand owing to product scarcity. COVID-19 brought a crisis to distribution networks and facility accessibility.

According to data out of **5800** small companies, **43% of retail shops** were shut down temporarily. Retailers faced trouble sustaining operational continuities offline as a result to quarantine, travel restrictions and **industrial shutdown**. Over a brief period of time supplier capacity reduced and consumer demand increased by 20% due to **lack of expertise** in dealing with these situations. The following were the main challenges faced by supply chain retailers :

- *Absence of supply chain adaptability*
- *Absence of government funding*
- *Lack of supply and demand balance*
- *Absence of confidence*
- *Communication problems*
- *Lack of security and safety*
- *Shortage of workforce*
- *Consumer attitude*
- *Lack of medical facilities*
- *Absence of viability*
- *Lack of access*

METHODOLOGY

1 . Identification of challenges faced by supply chain retailers :

The following identified problems are primarily found by retailers during supply chain management in COVID-19 era :

Table 1 :
List of challenges faced by retailers

S.No	Challenges
C1	Absence of Supply Chain flexibility
C2	Absence of government funding
C3	Absence of Confidence
C4	Communication problems
C5	Lack of security and safety
C6	Scarcity of work force
C7	Consumer attitude
C8	Maintainence of an appropriate balance among supply and demand
C9	Deficiency of surplus mnedical amenities
C10	Lack of viability
C11	Lack of access

The observed challenges faced by retailers are explained below :

- ***Absence of supply chain flexibility*** - Adapting flexibility had been an expensive procedure, developing a measure to balance prices and uncertainty.
- ***Absence of government funding*** - In the time of crisis adequate government funding could not be provided due to increased health expenses nationwide.

- ***Absence of confidence*** - Adhering to unforeseen circumstances traders lost confidence on how to cope up to the adverse conditions and were in a state of doubt and confusion.
- ***Communication problems*** - Due to lockdown, communication, transportation supplies became trapped amid locations. Merchants were ordered to close their shops due to absence of knowledge exchange.
- ***Lack of safety & security*** - Employees faced water Shortage, Danger of infection amid crisis.Also food distribution and cyber attacks were common.
- ***Scarcity of workforce*** - A lot of labours left for hometown amid crisis and industry shutdown.
- ***Consumer attitude*** - Uncertainty in buying attitude were noticed among buyers due to poor cash inflow. Substantial **stockpiling** was noticed.
- ***Balance supply & demand*** - *Inadequate essentials are kept in inventory and upsurge in demand created hurdles for supply chain to fulfill orders.*
- ***Deficiency of medical amenities*** - People often forgot basic medical amenities like mask, sanitizer and stores were lacking such basic supplies due to a huge production gap of these amenities.
- ***Lack of viability*** - Viability is an amalgamation of resilience, flexibility and renewability to be able to accomplish the supplies of different products to the public. It wa observed to be absent.
- ***Lack of access*** - To stop the spread of virus, the globe boldly imposed lockdowns which lead to stopping of basic essential activities also. **Transport** was disrupted, **manufacturers** were affected too.

2 . Identification of criterions

The following are the prime constraints in which the retailer's problems depend upon :

Table 2 :
List of criterias on which problems will be distinguised

Criteria	Designation	Criteria Type
Balance in supply and demand	P1	Beneficial (+)
Safety of employees	P2	Beneficial (+)
Trust between retailer and consumer	P3	Beneficial (+)
Distribution & transportation capabilities	P4	Beneficial (+)
Shortage of manpower	P5	Non Beneficial (-)
Consumer behaviour	P6	Beneficial (+)
Capacity constraint	P7	Non Beneficial (-)

- ***Beneficial criteria (+)*** : *higher values* are desirable
- ***Non-Beneficial criteria (-)*** : *lower values* are preferred

The above mentioned constraints are explained below :

- ***Balance in supply and demand*** - A significant rise in demand for certain supply chain (e.g. *food, goods*) that could not be met due to a limited supply due to the pandemic spreading across India at that time was experienced as the disease spread

- ***Safety of employees*** - It is critical to ensure the health and safety of employees who come in close contact with customers. It is essential to arrange sanitizing facility.

- ***Trust between retailer and consumer -*** When viruses spread via interaction with people and tainted items, credibility problems become the greatest difficulty for service stores and "no-touch delivery" industry.

- ***Distribution and transport capabilities*** - Resources and accessibilities are constrained, resulting in restricted strengths and capabilities.

- ***Shortage of manpower*** - The issue develops as a result of staff relocation to their hometowns, government restrictions aimed at minimising coronavirus transmission and concern of illness.

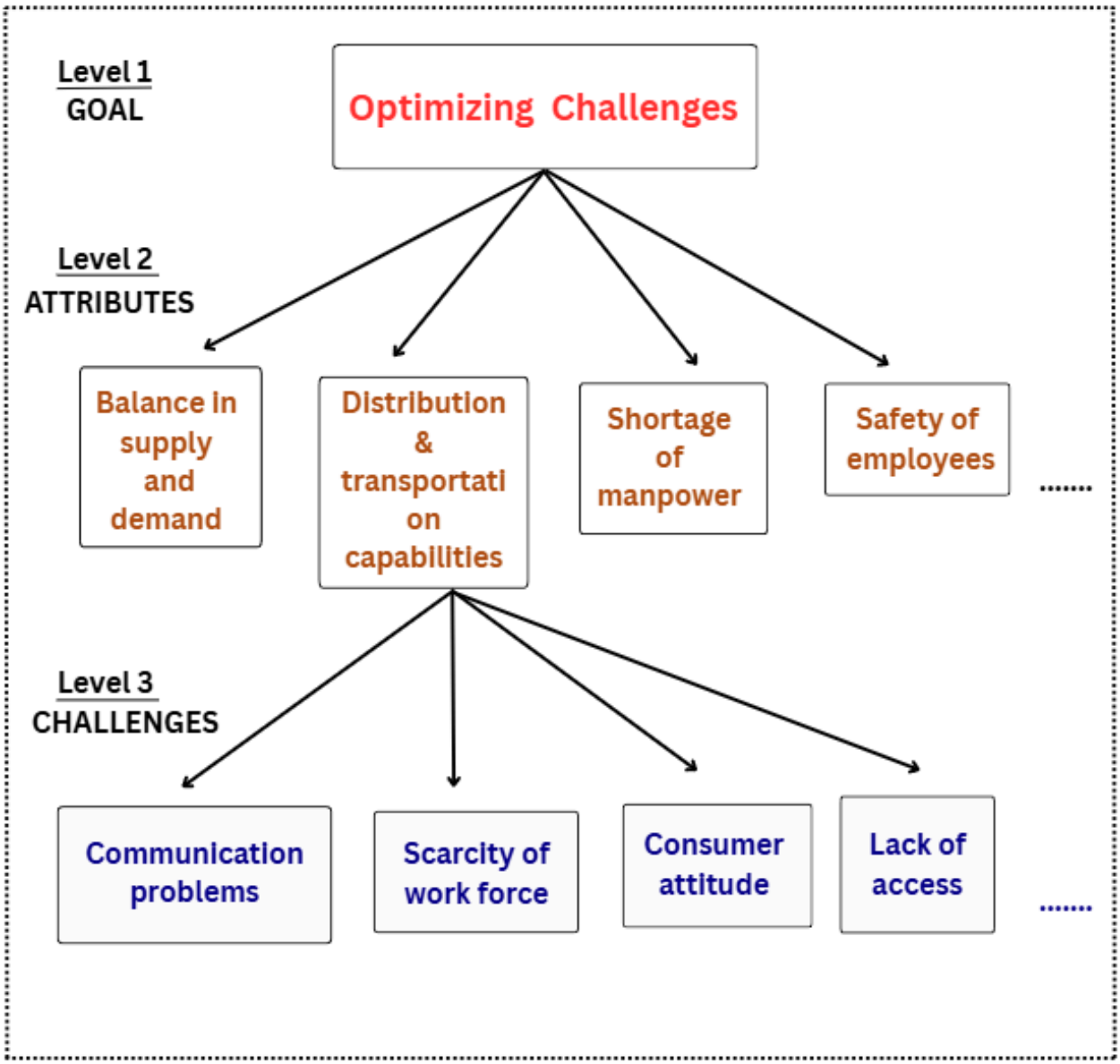
- ***Consumer behaviour*** - Consumer purchasing habits have shifted dramatically. It is currently concentrating on pharmaceuticals and basic everyday necessities. Collecting these items places an unneeded strain on merchants.

- ***Capacity constraint*** - *Scarcity of storage capacity at the commercial facility, businesses attempted to limit their manufacturing processes but were unsuccessful.*

3 . AHP Weightage

The following are the quick overview of AHP steps :

Step 1 - Develop a hierarchical structure with goal at the top level, the attributes at the second level and the challenges at the third level :



Step 2 - Determine the relative importance of different attributes with respect to the goal referring to expert's opinion and prepare the **Pair-wise comparison matrix** : *[Table 3]*

For example - How important is *Safety of employee* with respect to *Consumer Behaviour* attribute ?

Answer - Let *Consumer Behaviour* : **1x** value then,

Safety of employee : **4.786x** value ; which essentially means Safety of employee is 4.786 times more important than Consumer Behaviour attribute.

Table 3 :
AHP Pairwise Comparison Matrix

Attributes	Balance in supply and demand	Safety of employees	Trust between retailer and consumer	Distribution & transportation capabilities	Shortage of manpower	Consumer behaviour	Capacity constraint
Balance in supply and demand	1	1.0719489	2.743412849	1.670140586	2.97749749	4.7861276	6.426787428
Safety of employees	0.932880318	1	2.58965817	1.566847291	2.91438795	4.7893758	6.545955619
Trust between retailer and consumer	0.364509483	0.3861514	1	0.625885692	1.08323995	1.7587063	2.262581758
Distribution & transportation capabilities	0.59875199	0.6382243	1.597735838	1	1.69763278	2.9631427	3.775312461
Shortage of manpower	0.335852516	0.3431252	0.923156495	0.589055543	1	1.6679754	2.316696102
Consumer behaviour	0.208937179	0.2087955	0.568599782	0.337479524	0.59952922	1	1.436506787
Capacity constraint	0.155598736	0.1527661	0.441972979	0.264878738	0.43164919	0.6961332	1

Likewise, we have designed the entire decision matrix reflecting the interdepancy of attributes over one another. Obviously some constraints would be more prioritized over the other since every attribute doesnot have the same impact on supply chain.

- " 1 " : signifies equal importance
- " >1 " : signifies greater importance
- " <1 " : signifies lower importance

Step 3 - Prepare the **Normalized pair wise matrix** : *[Table 5]*

- Firstly we calculate the sum of records of each column. *[Table 4]*

Table 4 :
AHP Pairwise Comparison Matrix

Attributes	Balance in supply and demand	Safety of employees	Trust between retailer and consumer	Distribution & transportation capabilities	Shortage of manpower	Consumer behaviour	Capacity constraint
Balance in supply and demand	1	1.07194887	2.743412849	1.670140586	2.97749749	4.7861276	6.426787428
Safety of employees	0.932880318	1	2.58965817	1.566847291	2.91438795	4.7893758	6.545955619
Trust between retailer and consumer	0.364509483	0.38615135	1	0.625885692	1.08323995	1.7587063	2.262581758
Distribution & transportation capabilities	0.59875199	0.63822429	1.597735838	1	1.69763278	2.9631427	3.775312461
Shortage of manpower	0.335852516	0.34312522	0.923156495	0.589055543	1	1.6679754	2.316696102
Consumer behaviour	0.208937179	0.20879547	0.568599782	0.337479524	0.59952922	1	1.436506787
Capacity constraint	0.155598736	0.15276608	0.441972979	0.264878738	0.43164919	0.6961332	1
SUM	3.596530222	3.80101128	9.864536113	6.054287374	10.7039366	17.661461	23.76384016

- Secondly we calculate the sum of all records in a row to calculate the ***Weighted Sum*** value .
- Then we divide the weighted sum value by number of attributes to calculate the ***Criteria weights***. *[Table 5]*

Table 5 :
Normalizes Pair-wise Matrix

Attributes	Balance in supply and demand	Safety of employees	Trust between retailer and consumer	Distribution & transportation capabilities	Shortage of manpower	Consumer behaviour	Capacity constraint	Weighted Sum value	Criteria Weight
Balance in supply and demand	0.27804577	0.2820168	0.27810865	0.275860805	0.2781685	0.2709927	0.27044398	1.933637	0.27623
Safety of employees	0.25938342	0.2630879	0.26252204	0.258799623	0.2722725	0.2711766	0.27545866	1.862701	0.2661
Trust between retailer and consumer	0.10135032	0.1015917	0.10137324	0.10337892	0.1012001	0.0995788	0.09521112	0.703684	0.10053
Distribution & transportation capabilities	0.16648046	0.1679091	0.16196766	0.165172206	0.1585989	0.1677745	0.15886795	1.146771	0.16382
Shortage of manpower	0.09338237	0.0902721	0.09358337	0.097295603	0.0934236	0.0944415	0.09748829	0.659887	0.09427
Consumer behaviour	0.0580941	0.0549316	0.0576408	0.055742237	0.0560102	0.0566205	0.06044927	0.399489	0.05707
Capacity constraint	0.04326357	0.0401909	0.04480423	0.043750605	0.0403262	0.0394154	0.04208074	0.293832	0.04198
SUM	3.59653022	3.8010113	9.86453611	6.054287374	10.703937	17.661461	23.7638402		

Step 3 - Calculate the **Consistency** :

- Multiply each record in the every column of the **Non-Normalized** matrix with its respective criteria weight.
- Then **Weighted sum value** is calculated by taked the sum of every record in a row.
- Then we divide Weighted Sum value by respective Criteria weights to calculate .

Table 6 :
Consistency calculation

Criteria Weight	0.275	0.265	0.099	0.165	0.095	0.058	0.042			
Attributes	Balance in supply and demand	Safety of employees	Trust between retailer and consumer	Distribution & transportation capabilities	Shortage of manpower	Consumer behaviour	Capacity constraint	Weighted Sum Value	Criteria Weight	Lambda
Balance in supply and demand	0.275	0.2840664	0.271597872	0.275573197	0.2828623	0.2775954	0.26992507	1.93662	0.27666	7.177
Safety of employees	0.25654209	0.265	0.256376159	0.258529803	0.2768669	0.2777838	0.27493014	1.866029	0.26658	7.025
Trust between retailer and consumer	0.10024011	0.1023301	0.099	0.103271139	0.1029078	0.102005	0.09502843	0.704783	0.10068	7.155
Distribution & transportation capabilities	0.1646568	0.1691294	0.158175848	0.165	0.1612751	0.1718623	0.15856312	1.148663	0.16409	7.014
Shortage of manpower	0.09235944	0.0909282	0.091392493	0.097194165	0.095	0.0967426	0.09730124	0.660918	0.09442	7.148
Consumer behaviour	0.05745772	0.0553308	0.056291378	0.055684121	0.0569553	0.058	0.06033329	0.400053	0.05715	7.053
Capacity constraint	0.04278965	0.040483	0.043755325	0.043704992	0.0410067	0.0403757	0.042	0.294115	0.04202	7.021

- Then we calculate λ max :

$$\lambda max = \frac{7.17 + 7.025 + 7.155 + 7.014 + 7.148 + 7.053 + 7.012}{7} = \mathbf{7.082}$$

- Now we calculate the ***Consistency Index : C.I.*** $= \frac{\lambda max - n}{n - 1}$

$$\therefore \text{C.I.} = \frac{7.082 - 7}{7 - 1} = \mathbf{0.0136}$$; where n = number of criterias

- Now we calculate the ***Consistency Ratio*** $= \frac{\text{Consistency Index (C.I.)}}{\text{Random Index (R.I.)}}$

Random Index Table :

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Now, **C.I. = 0.0136 & R.I. = 1.32** $\therefore$ **C.R. = $\frac{0.0136}{1.32}$ = 0.0103**

$\because$ **Consistency Ratio (CR) = 0.0103 < 1.32 ;**

So we conclude our matrix is reasonably consistent. *[Table 7]*

Table 7 :

AHP Final Weights

Attributes	Final Criteria weight
Balance in supply and demand	0.275
Safety of employees	0.265
Trust between retailer and consumer	0.099
Distribution & transportation capabilities	0.165
Shortage of manpower	0.095
Consumer behaviour	0.058
Capacity constraint	0.042

4. TOPSIS assignment

Step 1 - Gathering data from retailers regarding the challenges they encounter and transforming it in linguistic terms (such as low, extremely low, high....) by referring to industry experts : *[Table 8]*

Table 8 :
Numerical equivalence of linguistic outcomes

Linguistic value	Numerical Equivalent
Low Importance	1
Moderate Importance	2
Strong Importance	3
Very strong Importance	4
Extreme Importance	5

The point of the above numeric translation is small shop owners or retailers verbally express their problems and difficulties. They cannot quantify properly. So after collecting information industry experts Do the job of translating the Linguistic expressions into Numerical quantification in order to form the decision matrix. This is needed because in order to perform ***mathematical and statistical operations*** we need numerical equivalents to proceed further.

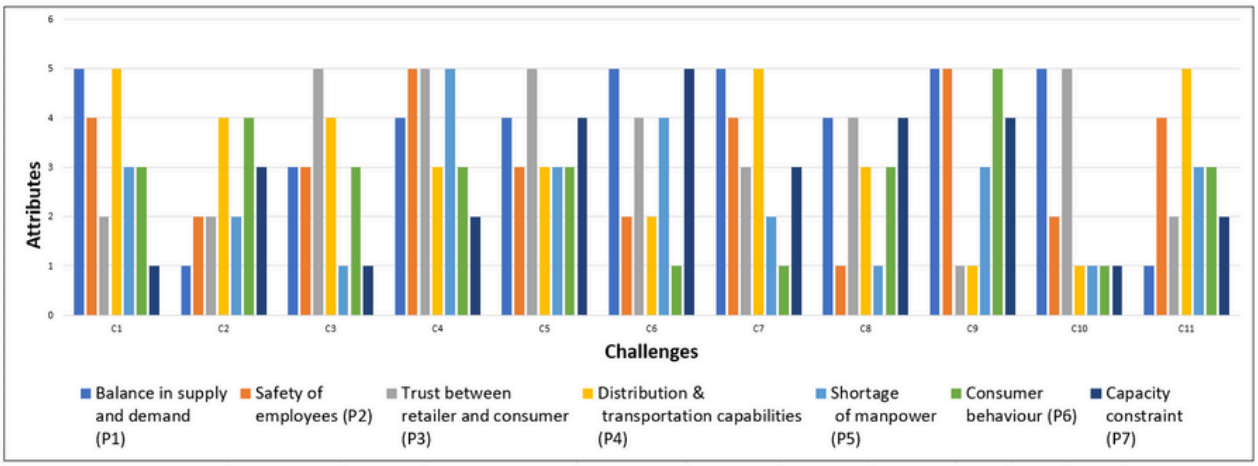
Step 2 - Transforming various linguistic terms into numerical values and developing the matrix : *[Table 9]*

Table 9 :
Linguistic equivalents assigned to different challenges by experts

S.No	Challenges	(P1)	(P2)	(P3)	(P4)	(P5)	(P6)	(P7)
C1	Absence of Supply Chain flexibility	5	4	2	5	3	3	1
C2	Absence of government funding	1	2	2	4	2	4	3
C3	Absence of Confidence	3	3	5	4	1	3	1
C4	Communication problems	4	5	5	3	5	3	2
C5	Lack of security and safety	4	3	5	3	3	3	4
C6	Scarcity of work force	5	2	4	2	4	1	5
C7	Consumer attitude	5	4	3	5	2	1	3
C8	Maintainence of an appropriate balance among supply and demand	4	1	4	3	1	3	4
C9	Deficiency of surplus mnedical amenities	5	5	1	1	3	5	4
C10	Lack of viability	5	2	5	1	1	1	1
C11	Lack of access	1	4	2	5	3	3	2

- The comparison of attributes of models in linguistic terms for every challenge is visualized in the form of BAR GRAPH. Here we intend to determine the impact of each attribute on a particular challenge and also relative to other challenges as well from the linguistic equivalent decision matrix shown above :

Comparison of attributes of models in linguistic terms :



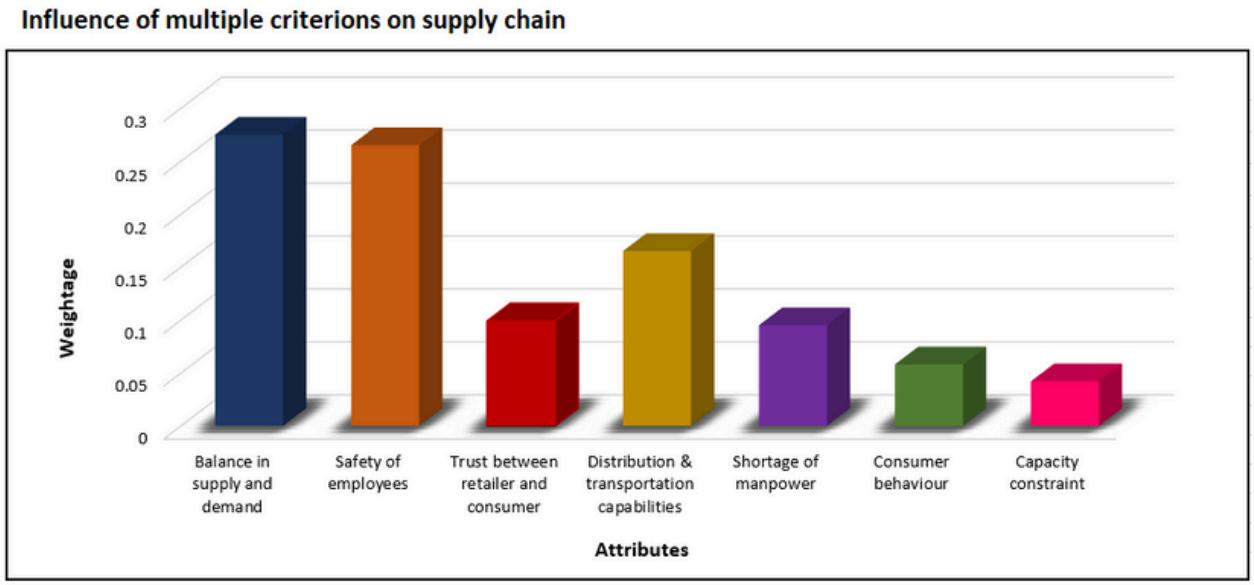
Step 3 - The identification and ranking of Aggregated weight assignment calculated in the previous part based on weightage :

[Table 10]

Table 10 :
Aggregated weights assigned process by experts

Identification	Criteria	Criterion	Rank
P1	Balance in supply and demand	0.275	1
P2	Safety of employees	0.265	2
P3	Trust between retailer and consumer	0.099	3
P4	Distribution & transportation capabilities	0.165	4
P5	Shortage of manpower	0.095	5
P6	Consumer behaviour	0.058	6
P7	Capacity onstraint	0.042	7

Now we visualize the relative importance of each attribute and it's influence on the supply chain in the form of a bar graph using criteria weight as the parameter :



Step 4 - Then we assign weights to different attributes in the matrix :

[Table 11]

Table 11 :
Weight assignment to attributes of various models

S.No	Challenges	(P1)	(P2)	(P3)	(P4)	(P5)	(P6)	(P7)
	Weightage	**0.275**	**0.265**	**0.099**	**0.165**	**0.095**	**0.058**	**0.042**
	Importance Criteria Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**
C1	Absence of Supply Chain flexibility	5	4	2	5	3	3	1
C2	Absence of government funding	1	2	2	4	2	4	3
C3	Absence of Confidence	3	3	5	4	1	3	1
C4	Communication problems	4	5	5	3	5	3	2
C5	Lack of security and safety	4	3	5	3	3	3	4
C6	Scarcity of work force	5	2	4	2	4	1	5
C7	Consumer attitude	5	4	3	5	2	1	3
C8	Maintainence of an appropriate balance among supply and demand	4	1	4	3	1	3	4
C9	Deficiency of surplus mnedical amenities	5	5	1	1	3	5	4
C10	Lack of viability	5	2	5	1	1	1	1
C11	Lack of access	1	4	2	5	3	3	2

Step 5 - Now we perform Vector Normalization on the matrix :

- Take square root of sum of squares of all records of a column.

Vector Normalization $$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} |x_{ij}|^2}}$$

Table 12 :
Calculating the Square root of sum of square of records

S.No	Challenges	(P1)	(P2)	(P3)	(P4)	(P5)	(P6)	(P7)
	Weightage	**0.275**	**0.265**	**0.099**	**0.165**	**0.095**	**0.058**	**0.042**
	Importance Criteria Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**
C1	Absence of Supply Chain flexibility	5	4	2	5	3	3	1
C2	Absence of government funding	1	2	2	4	2	4	3
C3	Absence of Confidence	3	3	5	4	1	3	1
C4	Communication problems	4	5	5	3	5	3	2
C5	Lack of security and safety	4	3	5	3	3	3	4
C6	Scarcity of work force	5	2	4	2	4	1	5
C7	Consumer attitude	5	4	3	5	2	1	3
C8	Maintainence of an appropriate balance among supply and demand	4	1	4	3	1	3	4
C9	Deficiency of surplus mnedical amenities	5	5	1	1	3	5	4
C10	Lack of viability	5	2	5	1	1	1	1
C11	Lack of access	1	4	2	5	3	3	2
	SQRT OF SUM OF SQUARE	**13.565**	**11.358**	**12.41**	**11.83**	**9.381**	**9.899**	**10.1**

- Now we divide each record of the column by their respective square root of sum of square values of respective column. And the value in each cell is called the normalized performance value

Table 13 :
Vector Normalized Matrix

S.No	Challenges	(P1)	(P2)	(P3)	(P4)	(P5)	(P6)	(P7)
	Weightage	0.275	0.265	0.099	0.165	0.095	0.058	0.042
	Importance Criteria Rank	1	2	3	4	5	6	7
C1	Absence of Supply Chain flexibility	0.37	0.35	0.16	0.42	0.32	0.3	0.1
C2	Absence of government funding	0.07	0.18	0.16	4	0.21	0.4	0.3
C3	Absence of Confidence	0.22	0.26	0.4	4	0.11	0.3	0.1
C4	Communication problems	0.29	0.44	0.4	3	0.53	0.3	0.2
C5	Lack of security and safety	0.29	0.26	0.4	3	0.32	0.3	0.4
C6	Scarcity of work force	0.37	0.18	0.32	2	0.43	0.1	0.5
C7	Consumer attitude	0.37	0.35	0.24	5	0.21	0.1	0.3
C8	Maintainence of an appropriate balance among supply and demand	0.29	0.09	0.32	3	0.11	0.3	0.4
C9	Deficiency of surplus mnedical amenities	0.37	0.44	0.08	1	0.32	0.51	0.4
C10	Lack of viability	0.37	0.18	0.4	1	0.11	0.1	0.1
C11	Lack of access	0.07	0.35	0.16	5	0.32	0.3	0.2

Step 4 - Determining the Weighted normalized decision matrix and Euclidean distances :

- We multiply each cell of the column by their respective weights.
- We then calculate the Ideal best & Ideal worst values for each column.

$V_j^+ =$ indicates the ideal (best) value

$V_j^- =$ indicates the ideal (worst) value

NOTE - For Beneficial criteria : Ideal Best = MAX value & Ideal Worst = MIN value

For Non-Beneficial criteria : Ideal Best = MIN value & Ideal Worst = MAX VALUE

- Now we calculate the ***Euclidean distance*** from Ideal Best :

$$S_i^+ = \left\{ \sum (v_{ij} - v_j^+)^2 \right\}^{0.5} \; ; \; j = 1, \; 2, \; \ldots, m \; ; i = 1, \; 2, \; \ldots, n$$

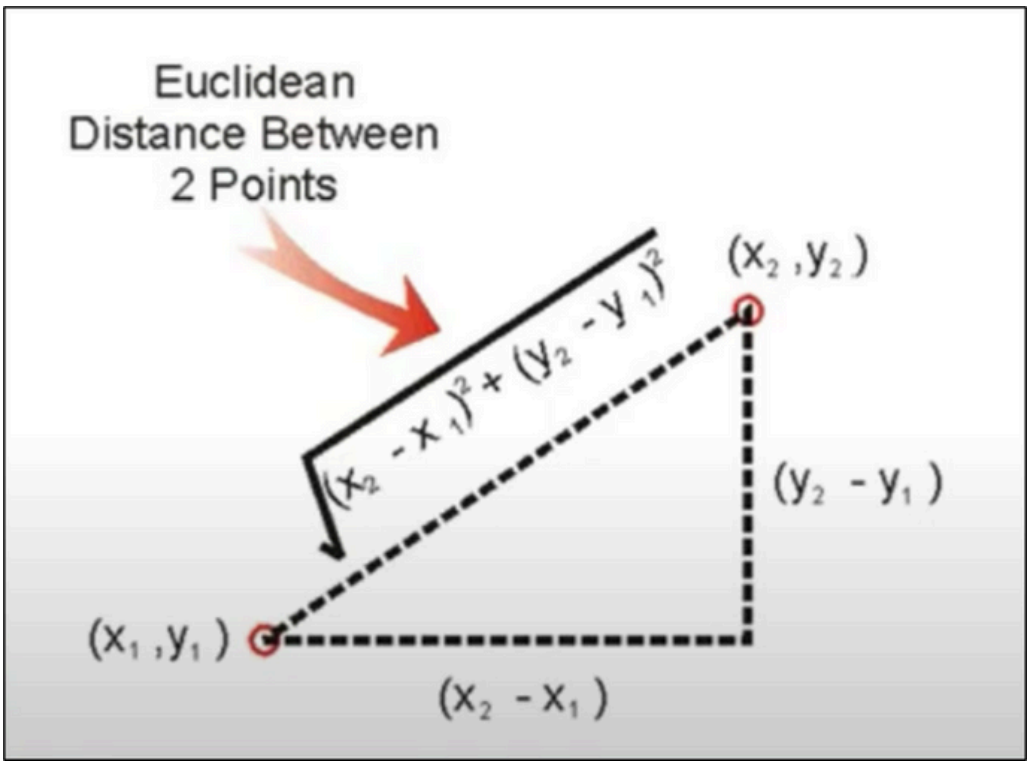
$$S_i^- = \left\{ \sum (v_{ij} - v_j^-)^2 \right\}^{0.5} \; ; \; j = 1, \; 2, \; \ldots, m \; ; i = 1, \; 2, \; \ldots, n$$

; Si+ = Euclidean distance from Ideal Best
Si- = Euclidean distance from Ideal worst

- Now we calculate the ***Performance Score*** for every challenge :

$$P_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

- Visualization of Euclidean Distance and it"s representation :



- Now we ***Rank*** the challenges on the basis of Performance score :

Table 14 :
Performance score matrix

S.No	Challenges	(P1)	(P2)	(P3)	(P4)	(P5)	(P6)	(P7)	Si+	Si-	Pi	Rank
	Weightage	0.275	0.265	0.099	0.165	0.095	0.058	0.042				
	Importance Criteria Rank	1	2	3	4	5	6	7				
C1	Absence of Supply Chain flexibility	0.1	0.09	0.02	0.07	0.03	0.02	0	0.76772	0.1261	0.14	11
C2	Absence of government funding	0.02	0.05	0.02	0.66	0.02	0.02	0.01	0.20224	0.5921	0.75	3
C3	Absence of Confidence	0.06	0.07	0.04	0.66	0.01	0.02	0	0.18193	0.5977	0.77	7
C4	Communication problems	0.08	0.12	0.04	0.5	0.05	0.02	0.01	0.33332	0.4499	0.57	4
C5	Lack of security and safety	0.08	0.07	0.04	0.5	0.03	0.02	0.02	0.33571	0.4418	0.57	5
C6	Scarcity of work force	0.1	0.05	0.03	0.33	0.04	0.01	0.02	0.50666	0.2811	0.36	8
C7	Consumer attitude	0.1	0.09	0.02	0.83	0.02	0.01	0.01	0.04359	0.7705	0.95	1
C8	Maintainence of an appropriate balance among supply and demand	0.08	0.02	0.03	0.5	0.01	0.02	0.02	0.34627	0.4398	0.56	6
C9	Deficiency of surplus mnedical amenities	0.1	0.12	0.01	0.17	0.03	0.03	0.02	0.66129	0.1755	0.21	9
C10	Lack of viability	0.1	0.05	0.04	0.17	0.01	0.01	0	0.664	0.1543	0.19	10
C11	Lack of access	0.02	0.09	0.02	0.83	0.03	0.02	0.01	0.0911	0.7639	0.89	2

Vj+	0.1	0.12	0.04	0.83	0.01	0.03	0
Vj-	0.02	0.02	0.01	0.07	0.05	0.01	0.02

- Now we ***Rank*** the challenges on the basis of Performance score in the decreasing order focussing the relative impact of challenges :

Table 15 :
Final Ranking of Challenges found in Supply Chain

Challenges	Pi	Rank
Consumer attitude	0.95	1
Lack of access	0.89	2
Absence of government funding	0.77	3
Communication problems	0.75	4
Lack of security and safety	0.57	5
Maintainence of an appropriate balance among supply and demand	0.57	6
Absence of Confidence	0.56	7
Scarcity of work force	0.36	8
Deficiency of surplus mnedical amenities	0.21	9
Lack of viability	0.19	10
Absence of Supply Chain flexibility	0.14	11

CONCLUSION

This project enumerates the multiple performance attributes of different popular problems dealt by retailers associated with supply chain. The purpose of this project was to determine the operational challenges and rank them in priority order.

I have included ***11 key obstacles*** confronted by retailers and ***7 attributes*** defining the challenges. From the final ranking chart we can conclude :

Consumer attitude was the major challenge among all. Public doubt the safety aspect of edible products, confusion prevailed regarding purchase of cosmetics and groceries. Other significant challenges on the ranking chart include '*lack of access*' for daily essentials and customized products, "*absence of government funding*' to small scale shops and dealers. Extreme cases of *miscommunication* was noticed which lead to uncertainty in demand forecasting and resulted in hikes and lows in marketplace for supply.

Therefor to sustain the supply chain one must try to prioritize these challenges in the ranking order and resolve in quick time for recovery in the marketplace. It would lead to customers once again regain confidence and shift in the customer attitude towards betterment. Finding the correct balance between supply and demand is also crucial and for that to achieve one need to be *flexible* and *adaptive* to changing trends in demand with time.In order to regain the workforce strength one must ensure good hygiene, proper safety and security within the working environment as per guidelines set by WHO. Finally with resilience, proper knowledge and recommendations policy makers must try to fix and help retailers adapt to the present conditions better.

LIMITATIONS & FUTURE SCOPE

Some Limitations of this project may include :

- *Expert's review might be biased or uni-directional due to different geographic locations.*
- *Other possible challenges prevalent post pandemic could also be integrated in addition to the existing ones.*
- *Limited criterias are considered which could be increased .*
- *Only one type of ranking method is used. Other hybrid methods could also be adopted for extensive study.*

The restrictions or constraints of the research may be taken into account and subsequent suggestions may be considered as a scope for future research :

- *A new model on ranking techniques can be explored in supply chain field.*
- *More input constraints or criterias might be considered.*
- *More research can be done for the challenges faced by retailers across different zones and locations.*

REFERENCES

- *Multi-criteria decision making in evaluating digital retrofitting solutions: utilising AHP and TOPSIS Procedia CIRP 2025 Abdulrahman Alqoud Jelena Milisavljevic-Syed Konstantinos Salonitis*

- *Sustainability in project risk management methodologies through the AHP-TOPSIS method applied to logistics and supply chain management Environmental and Sustainability Indicators June 2025 Patricia Navascués VegaUrtzi Llano Castresana*

- *AHP-TOPSIS social sustainability approach for selecting supplier in construction supply chain Cleaner Environmental Systems June 2021 Mohamed Marzouk Marwa Sabbah*

- *Using AHP-TOPSIS methodologies in the selection of sustainable suppliers in an electronics supply chain Cleaner Materials September 2022 Rakesh R. Menon V. Ravi*