DEVELOPMENT OF SUPPLY CHAIN ASSESSMENT MODEL USING AHP FOR AGRO IMPLEMENT MANUFACTURING INDUSTRIES AND ITS VALIDATION WITH CURRENT INDUSTRY APPLICATIONS

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Abstract— A comparative study was used to outline the lit- erature in the research topic. This paper presents an analytical study of agro manufacturing industries in region from year 2005 to 2018. The AHP considers a group of analysis criteria, and a group of other choices among that the most effective call is to be created. Its vital to notice that, since a number of the standards may be different, its not true normally that the most effective choice is that the one that optimizes every single criterion, rather the one that achieves the foremost appropriate trade-off among the various criteria. The AHP generates a weight for every analysis criterion in step with the choice makers try wise comparisons of the factors. the upper the burden, the additional vital the corresponding criterion. Next, for a fixed criterion, the AHP assigns a score to each option according to the decision makers pair wise comparisons of the options based on that criterion. The higher the score, the higher the performance of the choice with relevance the thought-about criterion. AHP combines the standards weights and also the choices scores, so deciding a worldwide score for every possibility, and a ensuing ranking. This paper present need of current era to study SCM in aggro manufacturing industries in vidarbha region by validating AHP parameters with current aggro manufacturing industrial scenarios.

I. INTRODUCTION

Supply chain management is an important subject among researchers as many studies focus on the integration of the supply chain that consists of information and material flows [1].The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It has particular application in group decision making and is used around the world in a wide variety of decision situations in fields such as government, business, industry, health care, shipbuilding and education. Users of the AHP first decompose their call downside into a hierarchy of a lot of simply appreciated sub- problems, every of which may be analyzed severally.

The weather of the hierarchy will relate to any facet of the choice problemtangible or intangible, rigorously measured or roughly calculable, well or poorly understoodanything the least bit that applies to the choice at hand. Associate importance of choosing suppliers is additionally a difficulty noticeably valued within the offer chain currently days. The integration strategy and the selection of suppliers are based on multi-criteria and technical decision-making processes[5].

The aim of this paper is to contribute to an aggro man- ufacturing industries study of multi-criteria decision-making methods. Our research took into account the AHP application in the Supply Chain management.

II. FINDINGS FROM LITERATURE SURVEY

1) Adopting various types of information technology en- ables elimination of excessive inventory by lowering the customization in the way to the supply chain.

2) Organizations need to have committed relationships with their customers because of their inherent barriers to competition.

3) Organizations have to understand the concepts and the practices of SCM if they have to remain competitive and enhance their profitability.
4) In strategic supplier partnership it is important to encourage supplier involvement in the product and service designing process if cost efficiency has to be achieved.
5) Organization should focus on effective use of informa- tion flow.
6) Relationship with customers and quality of information exchanged are affected depending upon the location of the company on the SC and its proximity to the consumer.
7) Need of SCM implementation model for smoothing the supply chain activities and increasing the efficiency and productivity in aggro implements manufacturing industries.

III. DATA COLLECTION

ocation oFinding Problems and its Responsible factors More than one criterion is usually needed to reach a
decision, therefore making it more complex. Hence, it is important to decompose the problem and to explicitly assess relevant criteria before come out for a decision. Many meth- ods have been developed to solve problems, and, common too many of them is the idea that most decision-making can be improved by breaking down the general evaluation of alternatives into evaluations on a number of relevant criteria. The methods differ on how they assess each criterion and on how they combine the evaluation of criteria to achieve a general evaluation.
We have given visits to more than 50 aggro manufacturing industries in vidarbh region and outside region also. Out of 50 participants, 40 were given active feedback to our ques- tionnaires and 10 were responded little bit. Collected data samples include 7 major factors and 34 sub factors. Factors are chosen by proper expert opinion and their experience in aggro manufacturing sectors. Below is a list of factors and sub factors that are considered for data analysis Hierarchical structure of data factors and its sub factor are

A. Data Sorting Analysis

Out of these too many factors, 33 factors are identified as a real time factors that mostly affects supply chain management process of an aggro manufacturing industries in region.Data Analysis is a step where all collected sam- ple data are examined and from it, a decision has to be taken. We proposed analytic hierarchical process model for data analysis. AHP model is a decision support model that gives a significance of factors in supply chain management process. Higher the value of factor more is a significance of factors/sub factors. Below is a list of sample factors/sub factors
Factors and Sub factors Factors and Sub-factors

1. Strategic Planning Performance Metric

Level of Customer Perceived value of budget
Order Lead Time
Information Processing Cost

2.Order Planning Metric

Total Cycle Time Customer Query Time
Product Development Cycle Time Accuracy of Forecasting
Planning Process Cycle Time Order Entry Point
Human Resource Productivity

3.Supplier Evaluation Metric

Supplier Delivery Performance Supplier Lead Time against Industry Norms
Pricing Against Market
Efficiency of Purchase Order Cycle Time

4.Production Metric Percentage of Default Cost

Per Operation Hours Capacity Utilization
Range of Product
Effectiveness of Scheduling Technique

5. Delivery Performance Measures

Quality of Delivery Goods On Time Delivery of Goods
Flexibility of Service System to Meet Customer Need Preparation of Distribution Planning Schedule Effectiveness of Delivery invoice method
Number of Faculties Delivery Notes noticed
Percentage of Urgent Delivery
Total Distribution Cost

6.Customer Service and Satisfaction

Flexibility Customer Query Time
Post Transaction Measures of Customer Service

7.Supply Chain Logistic Cost

Total Logistic Cost
Cost Associated with Assets and Return of an Investment

Information Processing Cost From score factors, an expert judgment matrix has been calculated for all factors and sub factors. we were collected data from Aggro Manufacturing Industries with based on 5 different experts opinions. These experts are famous person-alities in region and having more than 30 years of experience at aggro manufacturing industries. Eigen vectors matrix created for major factors is as below

TABLE I
EXPERT JUDGMENT MATRIX

	SPPM	OPM	SEM	PM	DPM	CSS	SCLC
SPPM	1.00	5.00	0.11	0.11	7.00	3.00	7.00
OPM	0.20	1.00	1.00	7.00	1.00	1.00	1.00
SEM	7.00	1.00	1.00	5.00	1.00	3.00	1.00
PM	5.00	0.14	0.20	1.00	5.00	5.00	5.00
DPM	0.14	1.00	1.00	0.20	1.00	3.00	1.00
CSS	0.33	1.00	0.33	0.20	3.00	1.00	3.00
SCLC	0.14	1.00	1.00	0.20	1.00	0.33	1.00

TABLE II
CALCULATION OF EIGEN VALUES FROM TABLE 1

	Total	Eigen Vector
SPPM	22.22	0.22
OPM	12.00	0.12
SEM	12.00	0.12
PM	16.34	0.16
DPM	7.20	0.07
CSS	8.53	0.08
SCLC	4.53	0.05

Eigen values represent to scaling importance of factors in multi criteria decision making process. Higher the Eigen value, higher the significance of factors in given set of criteria.

TABLE III
CALCULATION OF LAMBDA, CI AND CR

Levels	Sum Eigen Vector	Eigen Vector	Lambada
SPPM	1.92	0.22	8.69
OPM	0.94	0.12	7.85
SEM	1.54	0.12	12.90
PM	0.88	0.16	5.44
DPM	0.14	0.07	1.96
CSS	0.35	0.08	4.12
SCLC	0.01	0.05	0.14
		Total	41.10
		Average/Lambada max	5.87
		Consistency Index (CI)	0.19
		Average(ri)	1.35
		Consistency Ratio (CR)	0.14

where

$$\lambda = \sum Expert_Judgmrt * Eigen_Vector \setminus Eigen_Value$$

$$\sum Expert_Judgment = a1*b1+a2*b2+a3*b3+.an*bn$$

$$C_i = ABS(R_i/n - (E_i))/(sum(E_i) - 1)$$

$$C_r = C_i/R_i$$

Significance of Eigen value is directly proportional to importance of factor in supply chain management. Sum of judgment matrix specifies an impact of factors over others factors considered in performance measurement. Consistency indexes index measures of threshold value of performance. Having consistency index (Ci) means factors below it need to be considered for an improvement else factors is strong enough contributing in success of SCM process. Likewise an opinion from 5 different expert were collected of their Eigen Values are listed as below

TABLE IV
EXPERT OPINION

Meaning	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
SPPM	0.27	0.27	0.25	0.2	0.19
OPM	0.14	0.14	0.15	0.16	0.14
SEM	0.14	0.14	0.15	0.16	0.14
PM	0.2	0.2	0.2	0.19	0.24
DPM	0.09	0.09	0.09	0.1	0.1
CSS	0.1	0.1	0.11	0.12	0.12
SCLC	0.05	0.05	0.06	0.06	0.07

From TABLE III, One can Conclude that, all experts have their views similar to each other for factors sub factor. Strate- gic Planning Performance Metric has highest significance and Supply Chain Logistic Cost have lowest significance in supply chain management process. This shows that , there is need to enhance attention for factors like SCLC, CSS DPM etc.

IV. OBSERVATION

Observations are analytic conclusion made by researcher based on analysis. From above analysis, we can have a below observation

1) Factors like Strategic Planning Performance Metric, Order Planning Metric etc are strong in supply chain management process.

2) Data Collection and Analysis process done with prop- erly identified factors/sub factors.

3) Very Few factors like logistic cost, customer satisfac- tions etc have low Ci Cr values. There is a great scope of improvement in these factors.

4) All Experts have their views closer to each others.

5) Data Collected from 50 industries and 5 experts opin- ions are good enough to have a decision making process.

6) Values predicted by AHP model are more closer to expert opinion values. Thats why

AHP model can be validated and considered as ideal model for data prediction and analysis.

7) Eigen vector formed have a strong decision making values which leads to better calculation of lambda, consistency index and consistency ration.

V. VALIDATION OF PROPOSED AHP MODEL

To validate our proposed AHP model with current aggro manufacturing industrial scenarios, we have col- lected a sample values from three aggro manicuring industries. The experts list is given in an appendix. All Experts are famous personalities in aggro manufac- turing industries and each have a experience of more than 30 years. All are holding positions of at Managing Level.

A. Strategic Planning Performance Metric

Meaning	**A**	**B**	**C**
LCPVB	High	Medium	Medium
Ranking	1	2	2
Meaning	A	B	C
OLT	15	10	8
Ranking	3	2	1
Meaning	A	B	C
IPC	10 LK	9Lk	8LK
Ranking	1	2	3

B. Order Planning Metric

Meaning	**A**	**B**	**C**
TCT	20	11	15
Ranking	1	3	2
Meaning	A	B	C
CQT	1	3	1
Ranking	1	2	1
Meaning	A	B	C
PDCT	30	25	28
Ranking	1	3	2
Meaning	A	B	C
AF	70%	70%	100%
Ranking	2	2	1
Meaning	A	B	C
PBCT	3	3	4
Ranking	1	1	2
Meaning	A	B	C
OED	Online	Traditional	Traditional
Ranking	1	2	2
Meaning	A	B	C
HRP	85%	83%	92%
Ranking	2	1	1

C. Supplier Evaluation Metric

Meaning	**A**	**B**	**C**
SDP	60%	60%	60%
Ranking	1	1	1
Meaning	A	B	C
SLTAIN	80%	70%	80%
Ranking	1	2	1
Meaning	A	B	C
PAM	Low	Medium	Medium
Ranking	3	2	1
Meaning	A	B	C
EPOCT	93%	90%	95%
Ranking	2	3	1

D. Production Metric

Meaning	**A**	**B**	**C**
PD	23%	21%	24%
Ranking	2	1	3
Meaning	A	B	C
CPOH	30K	45K	46K
Ranking	1	2	3

Meaning	A	B	C
CU	60%	60%	50%
Ranking	1	1	2
Meaning	A	B	C
RP	83	80	75
Ranking	1	3	2
Meaning	A	B	C
EST	90%	95%	93%
Ranking	3	1	2

E. Delivery Performance Measures

Meaning	**A**	**B**	**C**
QDG	High	Medium	Medium
Ranking	1	2	2
Meaning	A	B	C
OTDG	100%	97%	80%
Ranking	1	2	3
Meaning	A	B	C
FSSMCN	Yes	Yes	Yes
Ranking	1	1	1
Meaning	A	B	C
EDPS	78%	80%	86%
Ranking	3	2	1
Meaning	A	B	C
EDIM	90%	88%	94%
Ranking	2	3	1
Meaning	A	B	C
NFDNN	20	12	10
Ranking	1	2	3
Meaning	A	B	C
PUD	20%	15%	20%
Ranking	1	2	1
Meaning	A	B	C
IRCD	Medium	Low	Medium
Ranking	2	3	1

Meaning	A	B	C
TDC	2LK	1.5LK	1.5LK
Ranking	1	2	2

F. Customer Service Satisfaction

Meaning	**A**	**B**	**C**
FX	Medium	Medium	Medium
Ranking	1	1	1
Meaning	A	B	C
CQT	1	1	1
Ranking	1	1	1
Meaning	A	B	C
PTMCS	High	High	High
Ranking	1	1	1

G. Supply Chain Logistic Cost

Meaning	**A**	**B**	**C**
TLC	5LK	4LK	4LK
Ranking	1	2	2
Meaning	A	B	C
CAARI	50K	45K	50K
Ranking	1	2	1
Meaning	A	B	C
IPC	1.5LK	1LK	1LK
Ranking	1	2	2

Rating given is as per data collected from Aggro Man- ufacturing Industries in vidharbh Region. An Eigen Vectors for each factors can be calculated as

H. Strategic Planning Performance Metric

Factor		A	B	C	Row Total	Eigen Vector
LCPVB	A	1	5	5	11	0.714285714
	B	0.2	1	1	2.2	0.142857143
	C	0.2	1	1	2.2	0.142857143
				Total	15.4	1
Factor		A	B	C	Row Total	Eigen Vector
OLT	A	1	5	7	13	0.728581116
	B	0.2	1	2	3.2	0.179343044
	C	0.14286	0.5	1	1.64286	0.092073438
				Total	17.8429	0.999997598
Factor		A	B	C	Row Total	Eigen Vector
IPC	A	1	1	2	4	0.421052632

	B	1	1	1	3	0.315789474
	C	0.5	1	1	2.5	0.263157895
				Total	9.5	1

like wise Eigen vectors for all factors and sub factors

are calculated. base on these Eigen values, we validate our proposed model as below

TABLE V
VALIDATION CALCULATION

Factors	Sub Variable Weight	Major Factor	Weights			Calculated Weights		
			A	B	C	A	B	C
LCPVB	0.29	0.23	0.71	0.14	0.14	0.05	0.01	0.01
OLT	0.31		0.73	0.18	0.09	0.05	0.01	0.01
IPC	0.39		0.42	0.32	0.26	0.04	0.03	0.02
TCT	0.15	0.14	0.70	0.06	0.24	0.01	0.00	0.00
CQT	0.21		0.25	0.50	0.25	0.01	0.01	0.01
PDCT	0.23		0.57	0.11	0.32	0.02	0.00	0.01
AF	0.12		0.20	0.20	0.60	0.00	0.00	0.01
PPCT	0.19		0.33	0.33	0.33	0.01	0.01	0.01
OEP	0.09		0.71	0.14	0.14	0.01	0.00	0.00
HRP	0.02		0.10	0.10	0.80	0.00	0.00	0.00
SDP	0.19	0.15	0.33	0.33	0.33	0.01	0.01	0.01
SLTAIN	0.14		0.33	0.33	0.33	0.01	0.01	0.01
PAM	0.58		0.11	0.32	0.57	0.01	0.03	0.05
EPOCT	0.09		0.32	0.11	0.57	0.00	0.00	0.01
PD	0.18	0.21	0.37	0.17	0.46	0.01	0.01	0.02
CPOH	0.11		0.20	0.40	0.40	0.00	0.01	0.01
CU	0.19		0.33	0.33	0.33	0.01	0.01	0.01
RP	0.26		0.63	0.31	0.06	0.03	0.02	0.00
EST	0.25		0.11	0.57	0.32	0.01	0.03	0.02
QDG	0.19	0.09	0.71	0.14	0.14	0.01	0.00	0.00
OTDG	0.15		0.53	0.42	0.05	0.01	0.01	0.00
FSSMCN	0.22		0.33	0.33	0.33	0.01	0.01	0.01
PDPS	0.07		0.08	0.16	0.76	0.00	0.00	0.00
EDIM	0.08		0.20	0.10	0.69	0.00	0.00	0.00
NFDNN	0.14		0.79	0.14	0.07	0.01	0.00	0.00
PUD	0.11		0.45	0.09	0.45	0.00	0.00	0.00
TDC	0.03		0.33	0.33	0.33	0.00	0.00	0.00
FX	0.19	0.11	0.33	0.33	0.33	0.01	0.01	0.01
CQT	0.45		0.33	0.33	0.33	0.02	0.02	0.02
PTMCS	0.36		0.33	0.33	0.33	0.01	0.01	0.01
TLC	0.24	0.06	0.82	0.09	0.09	0.01	0.00	0.00
CAARI	0.33		0.45	0.09	0.45	0.01	0.00	0.01
IPC	0.43		0.50	0.25	0.25	0.01	0.01	0.01

Calculated Weights can be formulated as

$$Cal_W t = Sub_W t * Major_F actor *$$

$$AHP_W tRanking = Sort \sum Cal_w t$$

$$Total = Cal_w t \sum$$

Final ranking based on their totals caan be shown as below.

TABLE VI
RANKING OF INDUSTRIES BASED ON CALCULATIONS

	A	B	C
Total	0.42	0.27	0.30
Ranking	1	3	2

Ranking that we got from above calculations is best matched with our proposed FAHP model. Hence our proposed fuzzy AHP model is best suited for aggro manufacturing industries. Further analysis shows that accuracy of prediction of scaling factors is more closer to existing aggro manufacturing industries.

VI. CONCLUSION

1. Performance Measurement supports strategy plan- ning and goal setting. Without ability to measure per- formance and progress, process of developing strategic plans and goal is less meaningful.
2. Measurement improves accountability, SC includes lots of entities from supplier's supplier to customer.
3. From literature review , it is seems that proposed model of supply chain evaluation is practically more useful than any other existing model.
4. Proposed model can e used to assess the Medium Scale Industries (MSI) on the basis of performance of its supply chain. It is also useful to compare MSI on the basis of performance of their supply chain.
5. Proposed model can be used to identify the weak links in SC and to prepare a plan to improve the performance level.

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APPENDIX

TABLE VII

LIST OF EXXPERTS

Name	Designation	Industry Name	Location
Mr. Sanjay Supe	Managing Director	GUKSS	MIDC Amravati
Mr. Ajay Tijare	Director	Jadhao Gear Ltd	MIDC Amravati
Mr. Shantanu Jadhoa	CEO	Jadhoa Boilers	MIDC Amravati
Mr. Manoj Khandelwal	Managing Director	Shriram Associates	MIDC Akola
Mr. Amit Pagdilwar	Joint Managing Director	Padson's Industries	MIDC Akola

TABLE VIII

LIST OF INDUSTRIES CONSIDERED FOR SURVEY

A	Jadhao GearsPvt. Ltd MIDC Amravati
B	Jadhao Agro Industries, MIDC Amravati
C	Jadhao Layland, MIDC Amravati

TABLE IX

LIST OF ABBREVIATIONS AND ITS MEANING

Sub-Parameter	Meaning
Level of Customer Perceived value of budget	LCPVB
Order Lead time	OLT
Information Processing Cost	IPC
Total Cycle Time	TCT
Customer Query Time	CQT
Product Development Cycle Time	PDCT
Accuracy of Forecasting	AF
Planning Barrier Cycle Time	PPCT
Order Entry Method	OEP
Human Resource Productivity	HRP
Supplier Delivery Performance	SDP
Supplier Lead Time against Industry Norms	SLTAIN
Pricing against Market	PAM
Efficiency of Purchase order Cycle Time	EPOCT
% of Defaults	PD
Cost of Operation Hours	CPOH
Capacity Utilization	CU
Range of Products & Services	RP
Effectiveness of Scheduling Techniques	EST
Quality of Delivery Goods	QDG
On Time Delivery of Goods	OTDG
Flexibility of Service System to Meet customer Need	FSSMCN
Effectiveness of Distribution Planning Schedule	EDPS
Effectiveness of Delivery invoice method	EDIM
Numbers of Faultiness delivery notes noticed	NFDNN
% of Urgent deliveries	PUD
Information richness in carrying out delivery	IRCD
Total Distribution Cost	TDC
Flexibility	FX
Customers Query Time	CQT
Post Transaction Measures of Customer Service	PTMCS
Total Logistic Cost	TLC
Cost Associated with assets & return of innovation	CAARI
Information Cost	IPC