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Modelling of Outbound Logistics Barriers of Rubberwood Processing Industries

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ABSTRACT

Rubberwood has established itself as one of the major timbers mainly for the production of panelboards, furniture and other furniture components within a period of 20 years. By analysing the supply chain of the industry, it is clear that the outbound logistics system has various barriers that hinder the growth of market share of the industry. Hence it is essential to identify the criticality of these barriers to improve the supply chain efficiency of the system.

A detailed review related with outbound logistics barriers has been conducted. After identifying 44 barriers from the literature review, the next step was to determine the critical barriers, by means of brainstorming technique. It was identified that 15 barriers were critical to outbound logistics of industry and interrelations between them were established using ISM (Interpretive Structural Modelling) Methodology. Driving and dependence power analysis (DDPA) /MICMAC analysis is used to classify the critical barriers. An Analytical Hierarchy Process (AHP) was then used to weigh the critical barriers and to prioritize them. Microsoft Excel simulation Software and Super Decision Software were used to conduct the assessments. The judgements were found to be consistent in both cases. Further, ISM-AHP integrated model was developed to improve the outbound logistics of rubberwood processing industries and thus overall market share.

It was observed that lack of customer focus, selling of product only through dealers and absence of direct contact with end customers were valued as the top priorities among critical barriers. Arrangement of outbound logistics barriers in a hierarchy and their categorization are the exclusive effort in the area of rubberwood processing industry. The study concludes with implications about analyses of outbound logistics barriers of the industry.

Keywords: Outbound logistics Barriers, Brainstorming Technique, Interpretive Structural Modelling (ISM), Analytical Hierarchy Process (AHP), Excel Simulation & Super Decision software, Prioritization , ISM-AHP Model.

1.INTRODUCTION

Kerala, the God's own country is well known for rubber plantations for a century. A large quantity of rubberwood is available in Kerala which when utilized innovatively can reduce deforestation in the state. A number of rubber based industries established in the state. But, its financial indicators are not up to the expectation.

By analyzing the supply chain of rubberwood processing industries, it is clear that the outbound logistics system of the industry faces numerous deficiencies. The Outbound logistics of rubberwood processing industry is hindered by various barriers in multi-directions.The barriers not only hinder the outbound logistics but also influence one another. In order to ensure the reliability and smoothness of the outbound logistics of rubberwood processing industries, these inhibitors have to be eradicated intelligently.

This paper discloses various barriers affecting the outbound logistics of rubberwood processing industries and its influence to one another. The developed framework offers a strong and efficient evaluation technique in decision making for improving market share by means of identifying and prioritizing the critical barriers.

2. LITERATURE REVIEW

Studies in the field of outbound logistics are growing in terms of number of publications over the last decade; consequently organizations have shown growing interest in the concept of outbound logistics. Many authors have discussed the importance of SCM [1, 6]. Liang, L et.al [10] has extensively reviewed the various methods to improve outbound logistics efficiency practices among organizations. Logistics adds value by making products available in the right place and at the right time.

Interpretive structural modelling (ISM) methodology is utilized to understand the mutual influences among the barriers so that those driving barriers, which can aggravate few more barriers and those independent barriers, which are mostly influenced by driving barriers, are identified [12]. Warfield first proposes ISM in 1973. It transforms unclear, poorly articulated mental models of systems in to visible, well-defined models, which will be useful for solving the problem under consideration. ISM is a learning process that enables individuals or groups to develop a map of the complex relationships between the many elements involved in a complex situation [14]. Its basic idea is to use Expert‘s practical experience and knowledge to decompose a complicated system into several sub-systems (elements) and construct a multilevel structural model. The various aspects of ISM are well-documented in literature world. Alvandi, M et al. [1] have used ISM methodology for modelling the variables of SCM for improving the performance of the supply chain. Luthra et al. [11] developed ISM model to evaluate the barriers of Green Supply Chain Management (GSCM) in the automobile industry in India. Atri, R [2] used ISM to identify for modelling the enablers of coordination in a supply chain. Sarmah et al. [14] used ISM and fuzzy MICMAC to identify and classify the key criterion of information sharing enablers that influence trust in a supply chain management. Shahabadkar, P et.al [13] analysed the variables of supply chain performance by using ISM. They also applied ISM methodology for understanding and establishing the relationship among the barriers for IT enabled supply chain management. Balasubramanian, S [4] applied ISM technique to study the adoption of renewable energy in India. Pramod, V.R et.al [12] developed driving and dependent power analysis (DDPA) to indicate the degree of dependence and driving power of criteria. Several examples of the use of ISM have appeared in the literature, which can be applied in various fields. The Analytic Hierarchy Process (AHP) is a Multi Criteria Decision Making (MCDM) and structured technique that represents a complex decision problem as a hierarchy with different levels. AHP helps the decision-maker facing a complex problem with multiple conflicting and subjective criteria. AHP uses the concepts of fuzzy set theory and hierarchical structure analysis for the selection of the most appropriate alternative among a set of feasible alternatives. The earliest AHP method was proposed by Van Laarhoven and Pedrycz (1983) in which the fuzzy numbers with triangular membership functions describe the fuzzy comparing judgment. Boender (1989) extended van Laarhoven and Pedrycz‘s method and developed a more robust approach to the normalization of the local priorities. Aviad, S [3] proposed a new method with the use of triangular fuzzy numbers and extent analysis method for the pairwise

comparison scale of AHP and the synthetic extent values of the pairwise comparisons, respectively. Furthermore, many AHP methods developed by various authors can be found in literature.
The studies reviewed so far have made clear that there have been a number of researches about rubberwood industry in general. The researches are either on performance level, profitability or linkages of rubberwood processing industries. However, there has been no research specifically looking for the interrelation among the outbound logistics barriers of rubberwood processing industries. Hence, the first step in this study is determining the barriers affecting the outbound logistics and their interrelations. This is the first study that investigates the barriers of rubberwood processing industries, and develops a ISM-AHP integrated model.

3.PROBLEM DEFINITION

From the pilot study conducted in five Rubber based industries in Kerala, it is seen that the market share of these industries are not appreciable. Expert opinions are collected to study the reasons for poor market share. They opined that the major reasons are due to the barriers of outbound logistic system of the rubber based products. Hence we have decided to conduct a detailed study to identify the various logistic problems and evaluate the degree of critically among the barriers and it shall be very useful to decision makers to take appropriate decision for eliminating the outbound logistics problems and thereby increasing the efficiency of the Supply Chain Management System.

4.RESEARCH METHODOLOGY

The barriers relevant to the outbound logistics of rubberwood processing industry are identified based on the Literature Survey and Expert opinion. The inputs are explored through systematic brain storming sections. Groups of Experts, five from rubberwood processing industry, three from academics, and two researchers are consulted for identifying the critical barriers of outbound logistics. This led to the finalisation of variables relevant to the study.

The figure.1 illustrates flow diagram of ISM Methodology.

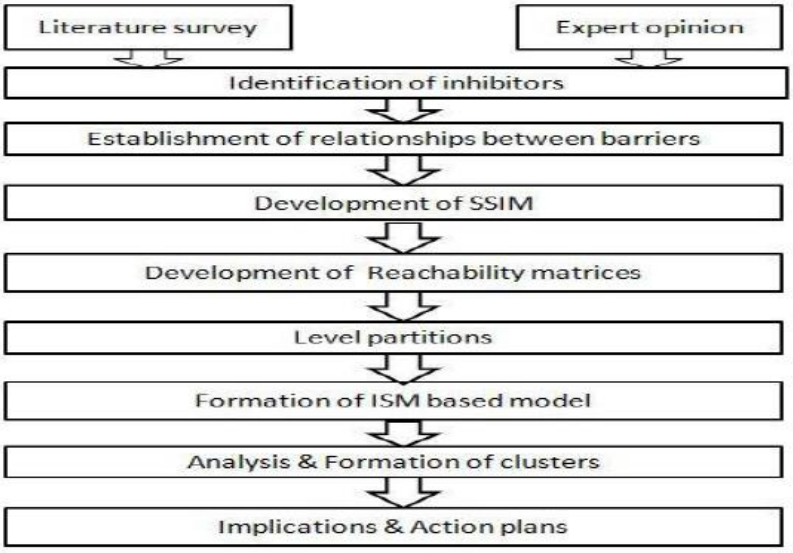

Fig 1: A schematic diagram of ISM Methodology

A. *Identification of outbound logistics barriers*

Forty four outbound logistics barriers of the Supply Chain System of industries are identified from the literature published till date. Then the critical outbound logistics barriers relevant to the Rubberised industries are identified from the opinion of a panel of Experts in the field. Then Experts are asked to indicate the importance of 44 listed barriers on a five-point Likert scale, where 1 stands for _very low

importance‘ and 5 for _very high importance‘. Those barriers that have mean value greater than 70% of its maximum value (i.e., 3.5) are considered as critical barriers of outbound logistics of rubberwood processing industries. Thereby 15 barriers are identified as the most critical barriers relevant to the industry under study and are given in Table I.

The mean and standard deviations of the data collected are calculated using SPSS (Statistical Package for Social Sciences) Software. The reliability of the data collected from the Experts is measured using Cronbach's alpha- coefficient. The value obtained (0.781) is considered as acceptable reliability.

TABLE I
CRITICAL OUTBOUND LOGISTICS BARRIERS OF RUBBERWOOD PROCESSING INDUSTRIES

Sl.No	Critical Barriers of rubberwood processing industries	Mean	Std. Deviation
1	Lack of customer focus	4.44	0.882
2	Selling of product only through dealers	4.33	0.500
3	Failure to penetrate into new markets	4.33	0.707
4	Failure to meet delivery schedule	4.22	0.667
5	Absence of direct contact with end customers	4.11	1.054
6	Low level utilization of overseas market	4.00	0.707
7	Low level of value addition in rubberwood	4.00	0.866
8	Lack of latest IT infrastructure	3.89	1.167
9	No advertisement done through medias	3.78	1.202
10	Low level of outbound logistics integration	3.78	1.394
11	Poor awareness programs about marketable advantages of rubberwood	3.67	0.500
12	No sales promotion	3.67	0.500
13	Feedback from dealers rarely taken	3.56	0.527
14	Lack of sufficient R&D activities in rubberwood industry	3.56	0.882
15	Over influence of foreign companies in regional market	3.56	1.424

B. *Development of Structural Self-Interaction Metrics (SSIM)*

Development of interpretive structural model starts with the preparation of a structural self-interaction matrix, which shows the direction of contextual relationships among the elements. In developing SSIM, following four symbols have been used to denote the direction of relationship between two barriers i and j. Table II shows the rules for forming SSIM.

The reliability of the responses from experts is tested by calculating Cronbach‘s alpha value. 0.935 is considered as High reliability which is acceptable. Based on the relationships among the inhibitors the SSIM is developed. It is shown in Table III.

TABLE II RULES FOR FORMING SSIM

Symbol	Relationship between row (i) and column (j) elements
V	Barrier i will lead to barrier j , not in reverse direction
A	Barrier j will lead to barrier i , not in reverse direction
X	Barrier i and j will lead to each other, in both directions
O	Barrier i and j are unrelated

TABLE III STRUCTURAL SELF-INTERACTION METRICS FOR BARRIERS

B. No	Outbound logistics barriers of rubberwood processing industry	BARRIER NUMBER														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Selling of product only through dealers		V	O	O	V	V	O	O	V	V	V	O	V	X	X
2	Failure to penetrate into new markets			A	A	X	A	X	X	A	A	X	O	A	A	A
3	Lack of integration of latest IT infrastructure				O	V	V	V	O	V	O	V	O	V	X	X
4	Low level of value addition in rubberwood					X	X	X	V	A	X	V	A	V	O	X
5	No sales promotion						V	X	V	V	X	X	O	V	O	X
6	Absence of direct contact with end customers							A	V	A	X	O	O	V	X	X
7	Feedback from dealers rarely taken								O	V	O	O	O	V	A	X
8	Over influence of foreign companies in regional market									A	A	V	O	X	A	A
9	Poor awareness programs about marketable advantages of rubberwood										A	V	V	O	A	V
10	No advertisement done through medias											V	O	V	O	X
11	Low level utilization of overseas market												A	A	A	O
12	Lack of sufficient research and developmental activities in rubberwood industry													O	O	X
13	Failure to meet delivery schedule														X	A
14	Low level of outbound logistics integration															V
15	Lack of customer focus															

C. *Development of Reachability Matrix*

This is a metrics of only binary elements. The SSIM has been converted in to a binary matrix, named Reachability Matrix by substituting V, A, X, O by 1 or 0 applying the following rules:

• If (i, j) value in the SSIM is V, (i, j) value in the reachability matrix will be 1 and (j, i) value will be 0
• If (i, j) value in the SSIM is A, (i, j) value in the reachability matrix will be 0 and (j, i) value will be 1
• If (i, j) value in the SSIM is X,(i, j) value in the reachability matrix will be 1 and (j, i) value will also be 1

• If (i, j) value in the SSIM is O,(i, j) value in the reachability matrix will be 0 and (j, i) value will also be 0

By applying these rules, reachability matrix for the barriers has been obtained (Table IV). The driving power and the dependence power of each barrier have also been shown in the Table IV. Driving power and dependence power are calculated by adding the number of ones in the rows and columns of each barrier respectively. These driving power and dependence help to classify the inhibitors into four clusters.

D. *Partitioning of Levels*

The reachability and antecedent set for each barrier have been determined from the final reachability matrix. The reachability set for a barrier consists of the barrier itself and the other barriers, which it influences. The antecedent set consists of the barrier itself and other barriers, which may influence it. The variables, which are common in reachability set and antecedent set, are allocated at the intersection set.

TABLE IV
REACHABILITY MATRIX FOR OUTBOUND LOGISTICS BARRIERS

BARRIERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Driving Power	
																SUM	RANK
1	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	10	3
2	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0	5	5
3	0	1	1	0	1	1	1	0	1	0	1	0	1	1	1	10	3
4	0	1	0	1	1	1	1	1	0	1	1	0	1	0	1	10	3
5	0	1	0	1	1	1	1	1	1	1	1	0	1	0	1	11	2
6	0	1	0	1	0	1	0	1	0	1	0	0	1	1	1	8	4
7	0	1	0	1	1	1	1	0	1	0	0	0	1	0	1	8	4
8	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	4	6
9	0	1	0	1	0	1	0	1	1	0	1	1	0	0	1	8	4
10	0	1	0	1	1	1	0	1	1	1	1	0	1	0	1	10	3
11	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	3	7
12	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	4	6
13	0	1	0	0	0	0	0	1	0	0	1	0	1	1	0	5	5
14	1	1	1	0	0	1	1	1	1	0	1	0	1	1	1	11	2
15	1	1	1	1	1	1	1	1	0	1	0	1	1	0	1	12	1
Dependence Power	3	14	3	8	9	10	7	10	7	6	12	3	11	5	11	119/119	
SUM																	
RANK	10	1	10	6	5	4	7	4	7	8	2	10	3	9	3		

Thus, antecedent set and intersection set are located. This leads to locate the top-level element. The top-level element for each hierarchy is the elements in which antecedent set and intersection set are same in the ISM hierarchy. Once the top level barrier is identified, it is removed from consideration and other top level barriers are found. This process will be continued till all levels of each barrier are found. The levels identified by this procedure have been utilized for the formation of ISM Model. In the present work, the fifteen outbound logistics barriers, along with their reachability set, antecedent set, intersection set and levels, are calculated. Level identification process of these barriers can be completed in seven iterations, which can be summarized as Table V.

E. *Formation of ISM based model*

From the reachability metrics, a preliminary model, called digraph, has been developed by means of vertices or nodes, and lines of edges. The digraph is converted into the final ISM model by replacing the criteria nodes with statements. The ISM based model is reviewed for conceptual inconsistency and the final model is presented in Figure 2. If there is a relationship between the barriers j and i, this is shown by an arrow which points to from i to j.

F. *Classification of Barriers (MICMAC analysis)*

Matrice d'Impacts croises-multipication appliqu´ean classment (cross-impact matrix multiplication applied to classification) is abbreviated as MICMAC, developed by Michel Godet in 1975. The purpose of a MICMAC analysis is to analyse the driver and dependence power of the barriers. This is done to identify the key barriers that drive the system. Here the driving power and dependence of barriers are determined from the reachability matrix (Table IV). A graph between dependence power and driving power of the barriers is presented in Figure 3.

TABLE V
PARTITIONING OF REACHABILITY MATRIX SHOWING ALL LEVELS OF BARRIERS

Barriers	Reachability set	Antecedent set	Intersection set	Level
1	1,2,5,6,9,10,11, 13,14,15	1,14,15	1,14,15	VII
2	2, 5, 7, 8, 11	1,2,3,4,5,6,7,8,9, 10,11,13,14,15	2, 5, 7, 8, 11	I
3	2,3,5,6,7,9,11, 13,14,15	3,14,15	3,14,15	VII
4	2,4,5,6,7,8,10, 11,13,15	4,5,6,7,9,10, 12,15	4,5,6,7,10,15	III
5	2,4,5,6,7,8,9,10, 11,13,15	1,2,3,4,5,7, 10,11,15	2,4,5,7,10, 11,15	VI
6	2,4,6,8,10,13, 14,15	1,3,4,5,6,7,9, 10,14,15	4,6,10,14,15	III
7	2,4,5,6,7,9,13,15	2,3,4,5,7,14,15	2,4,5,7,15	VI
8	2,8,11,13	2,4,5,6,8,9,10, 13,14,15	2,8,13	II
9	2,4,6,8,9,11,12,15	1,3,5,7,9,10,14	9	V
10	2,4,5,6,8,9,10, 11,13,15	1,4,5,6,10,15	4,5,6,10,15	VI
11	2, 5, 11	1,2,3,4,5,8,9,10, 11,12,13,14	2, 5, 11	I
12	4,11,12,15	9,12,15	12,15	IV
13	2,8,11,13,14	1,3,4,5,6,7,8,10, 13,14,15	8,13,14	II
14	1,2,3,6,7,8,9,11, 13,14,15	1,3,6,13,14	1,3,6,13,14	VII
15	1,2,3,4,5,6,7,8,10, 12,13,15	1,3,4,5,6,7,9, 10,12,14,15	1,3,4,5,6,7, 10,12,15	III

Fig 2. Interpretive Structural modeling of outbound logistics barriers

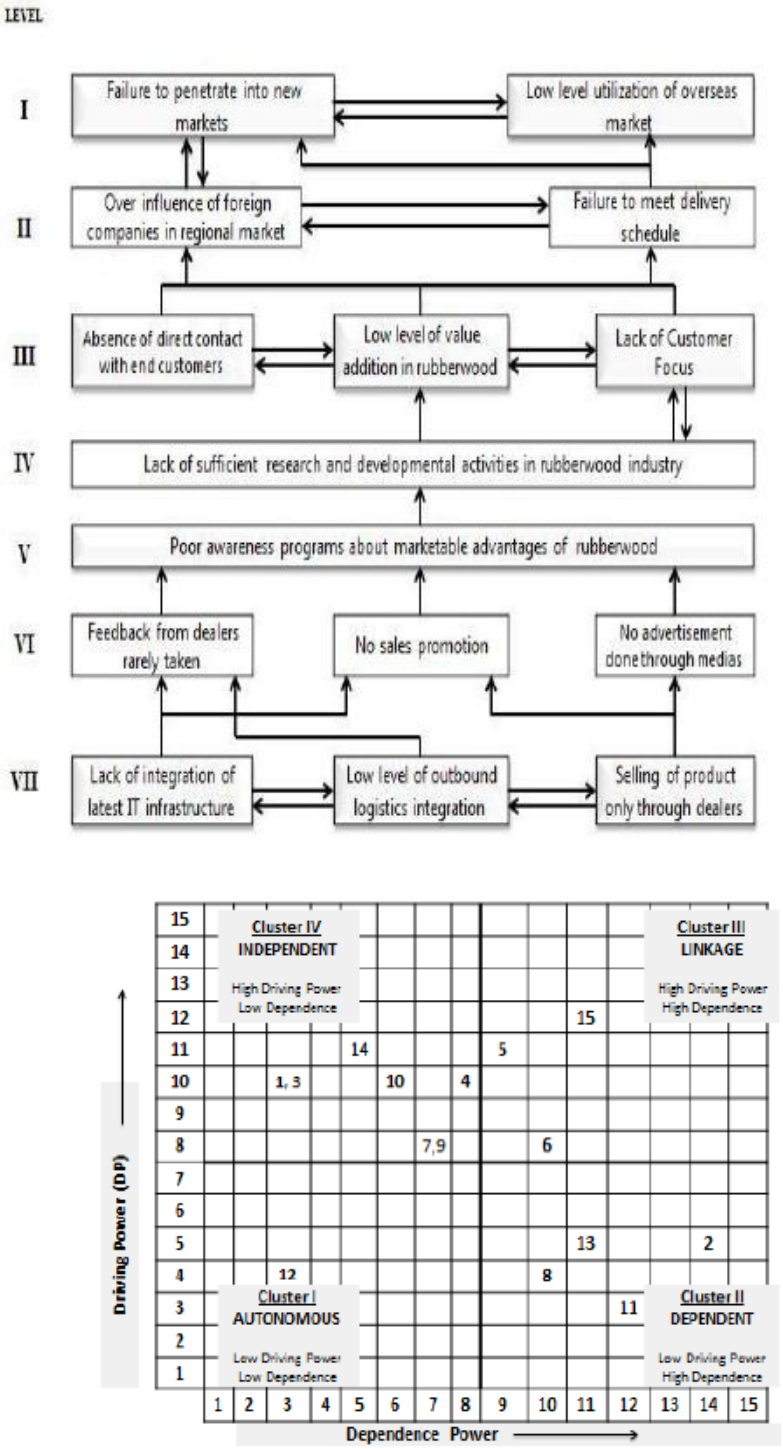

Fig3. Driving Power-dependence diagram for barriers (MICMAC analysis)

All barriers are classified based on driving and dependence power analysis (DDPA) into four clusters; autonomous, dependent, linkage and independent barriers. The first cluster consists of the **—autonomous barriers‖** that have weak driver power and weak dependence. The second cluster consists of the **dependent barriers** that have weak driver power but strong dependence. Third cluster has the **linkage**

barriers that have strong driving power but also strong dependence. The fourth cluster includes the **independent barriers** having strong driving power but weak dependence.
Then a pair-wise comparison is done in terms of which element dominates the other. There are [n (n−1)/2] judgments required to develop the set of matrices. Reciprocals are assigned in each pair-wise comparison. Table VI shows AHP rating scale proposed by Saaty.
For any pair of criteria *i, j*:

TABLE VI SAATY RATING SCALE

Score	Relative importance
1	Equal importance of i and j
3	Moderate importance of i over j
5	Strong importance of i over j
7	Very strong importance of i over j
9	Absolute (extreme) importance of i over j

When the value of an element i against j is n, then an element j's importance against the element i is 1/n. Figure.4 shows pair wise comparison matrix of each barriers.

G. *Prioritization of Barriers*
The weight value of the barriers in each layer of the ISM framework is calculated using Analytical Hierarchy Process (AHP). The AHP version normalizes the pair-wise comparison values within each of the matrices and then averages (normalize) the values in each row to get the corresponding weights and ratings. For the pair-wise comparisons the nine
point scale used by T. L. Saaty has been used with respect to judges on the alternatives. Such matrices are evaluated based on the numerical value on the scale 1 to 9 to every pair of alternatives assigned by the Experts. The Procedure of AHP is defined as:
1. Developing a pair wise comparison matrix for each criterion
2. Normalizing the resulting matrix
3. Averaging the values in each row to get the corresponding rating
4. Checking the consistency of the pair-wise comparison matrix by calculating the consistency ratio.
Consistency Ratio CR=CI/RI where,
CI is the Consistency Index and
RI is the Random Consistency Index Ratio
If CR<0.1, Then the evaluations are consistent

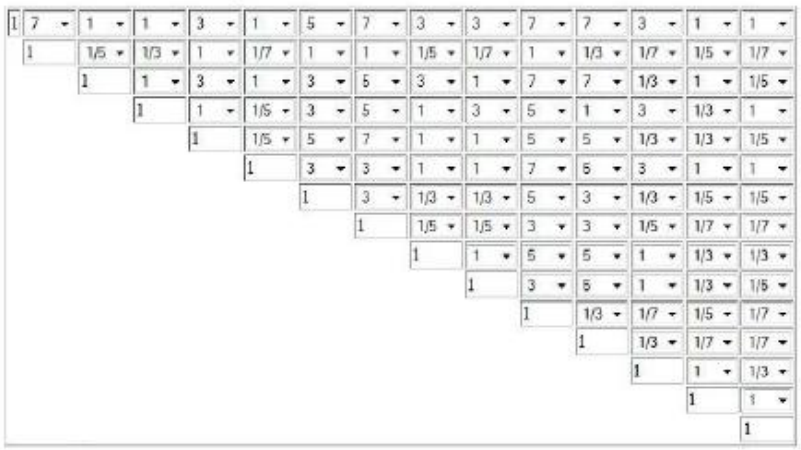

Fig.4. Pair wise comparison matrix of barriers using AHP

Pair wise comparison matrix is done using Microsoft Excel Simulation software. Normalising the resulting matrix using Excel 2010 Simulation Software and averaging the values in each row is done to get the corresponding weight of each barrier. The consistency measure of all the fifteen barriers is measured. The calculation of consistency ratio is shown below.

Consistency Index,CI = (λmax-n)/(n-1)

=(17.08269 -15)/ (15-1) = 0.14876

Consistency ratio (CR) = CI / RI

n= Number of Barriers (15)

RI=1.59 for 15 barriers. [Aviad,s [3]]

Consistency ratio (CR) = 0.14876 / 1.59 = 0.0935

CR Value less than 0.1, so the evaluations are consistent.

Ranking of the ISM results using the AHP technique is shown in Table VII**.** The Expert's view on pair wise comparison makes the result more accurate and realistic.

H. *ISM- AHP Model Development*

The relative weight of each outbound logistics barrier is identified using AHP. The weight of all barriers in each level of ISM hierarchy is calculated and then, the result of AHP is applied on ISM Model. Thus integrated ISM-AHP model is developed (Figure.5), which shows normalized weights of barrier in each level of hierarchy.

TABLE VII AHP MODELLING USING EXCEL SIMULATION & SUPER DECISION SOFTWARES

Barriers	Outbound logistics barriers of rubberwood processing industry	Weights Using Microsoft Excel	Weights Using Super Decisions
B15	Lack of customer focus	0.145723	0.14997
B1	Selling of product only through dealers	0.11763	0.11735
B6	Absence of direct contact with end customers	0.115296	0.11758
B14	Low level of outbound logistics integration	0.114052	0.11404
B3	Lack of integration of latest IT infrastructure	0.086178	0.08422
B4	Low level of value addition in rubberwood	0.076068	0.07668
B13	Failure to meet delivery schedule	0.076042	0.07630
B9	Poor awareness programs about marketable advantages of rubberwood	0.060324	0.05933
B10	No advertisement done through medias	0.059546	0.05899
B5	No sales promotion	0.051618	0.05111
B7	Feedback from dealers rarely taken	0.028359	0.02717
B12	Lack of sufficient R&D activities in rubberwood industry	0.020949	0.02034
B8	Over influence of foreign companies in regional market	0.019138	0.01833
B2	Failure to penetrate into new markets	0.0166	0.01660
B11	Low level utilization of overseas market	0.012477	0.01199
TOTAL		1	1
Consistency ratio (CR)		0.0935	0.0938

5.RESULTS & DISCUSSION

The levels of different outbound logistics barriers are important in better understanding and their implications for improving market share of the industry. The results of this study helps the decision makers to take strategic and tactical decisions for rubberwood processing industries to move from a traditional system of outbound logistics into an improved system, that results in increase of market share. The main strategic decision relies on the actions based on the customer focus activities. Lack of Customer focus of rubberwood processing industry is the barrier that has more weightage (0.1457). In many occasions it will lead to reduction of market share of rubberwood processing industries. Hence due attention must be given to focus on the needs of the customers. It was also identified that some barriers listed in Table VIII are the root causes for all other barriers. It should be addressed as a priority basis in order to resolve problems in outbound logistics of industry.

A. *Findings of the study*

1. Lack of Customer focus of rubberwood processing industry is the barrier that has highest driving power and more weightage.

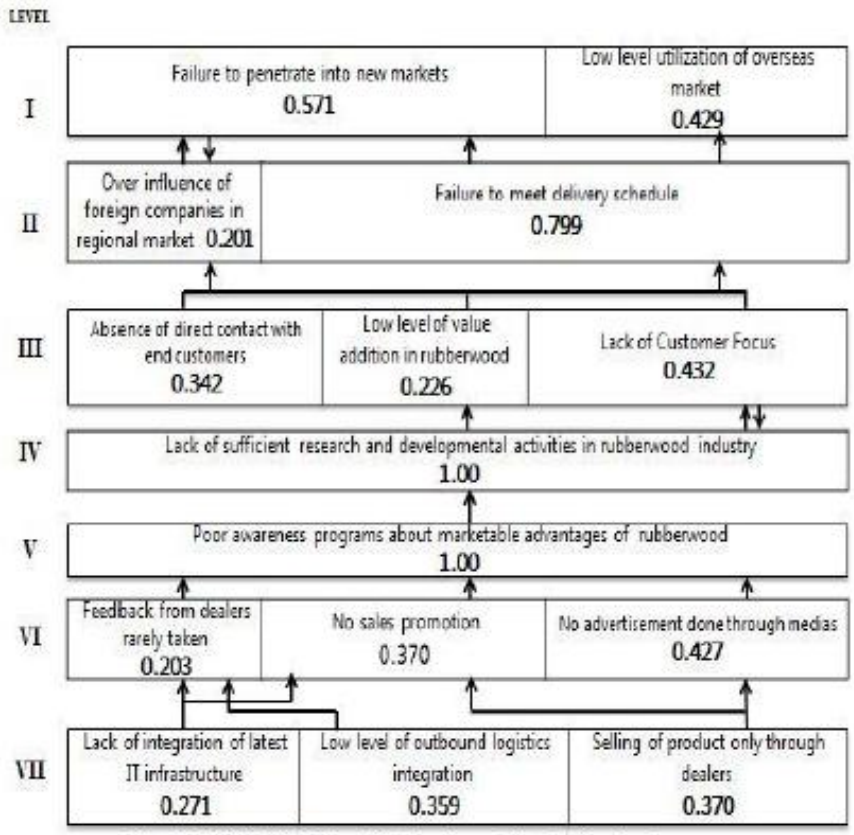

Fig.5. ISM-AHP Model of outbound logistics barriers

TABLE.VIII PRIORITIZATION OF BARRIERS

Priority	Outbound logistics barriers of rubberwood processing industry	Normalized Weights
1	Selling of product only through dealers	0.1176
2	Low level of outbound logistics integration	0.1140
3	Lack of integration of latest IT infrastructure	0.0862
4	Low level of value addition in rubberwood	0.0761
5	Poor awareness programs about marketable advantages of rubberwood	0.0603
6	No advertisement done through medias	0.0595
7	Feedback from dealers rarely taken	0.0284

2. Lack of customer focus, absence of direct contact with end customers and no sales promotion are linkage barriers- unstable in nature (High Driving power and High dependence). Any action on these barriers shall effect on others & feedback effect on themselves.
3. Failure to penetrate into new markets , low level utilization of overseas market, failure to meet delivery schedule, and over influence of foreign companies in regional market are weak drivers but strongly dependent on other barriers.
4. Lack of sufficient research and developmental activities in rubberwood industry is the only autonomous factor- less influence on other barriers (Weak driver and weak dependent)
5. Independent barriers (Drivers) can be treated as root cause for all barriers. It should be addressed as a priority basis in order to resolve problems in outbound logistics of industry.

B. *Suggestions and Recommendations*
Based on the above study, the following recommendations are to be implemented to prevent the outbound logistics barriers
of the system in order to improve the market share in the context of global competition.
1. The Customers are the focal point of any industry. Rubberwood Processing industry must introduce more activities based on customer focus. Identify the need of customers, supplying quality products to customers at right time at a minimum cost etc. are essential to increase the customer satisfaction.
2. Presently, the rubberwood processing industry in Kerala following dealership marketing. They sell their products through dealers only. So it is important to introduce direct marketing along with dealership marketing, in order to satisfy more customer requirements.
3. The industry must be strictly review its present outbound logistics system and rectify the various problems in the chain of outbound logistics. The proper flow of information between various members of chain is very important.
4. Rubberwood Processing industry in Kerala is not IT enabled. So it is important to capitalize the advantages of e-business, e-procurement, e-commerce, RFID technologies etc. in this industry.
5. It is very important to conduct more awareness programmes about more marketable advantages of rubberwood compared to traditional timbers. It will help in changing the attitude of people towards the rubberwood products.
6. In this technological development World, the industry must increase its advertisements through Medias like Television, Newspapers, Online Medias etc. The companies must provide sufficient budget provision for their advertisements. More Sales promotional activities must be taken up every year.

7. Take feedback from its dealers at regular intervals. They must be given incentives to those dealers who achieve their target to promote business.

6. CONCLUSION

Globalization of markets, e-business and introduction of new technologies give rise to new challenges to outbound logistics. If proper attention is not provided, various barriers damage the entire chain by the virtue of their intangible complexity and unpredictable dependence. This study presents a hierarchical framework for evaluating the barriers of rubberwood processing industries. The critical barriers affecting outbound logistics of rubberwood processing industries have been identified.

The barriers are grouped on the basis of Expert opinion to form 15 relevant barriers. Interpretive Structural Modelling (ISM) technique is applied to develop a structural model. Driving and dependence power analysis (DDPA) is used to classify the critical barriers. The method of AHP is introduced to calculate the criticality of the barriers in each layer of the ISM model. The developed ISM-AHP framework offers a strong and efficient evaluation technique for improving market share of the industry. The iterative process of the proposed ISM model helps to identify the level for each barriers, their strength of interrelationship, barriers classification (MICMAC Analysis) and frame strategies to mitigate them. AHP (using Microsoft Excel simulation & Super Decisions software) is used to calculate the weights of barriers in each layer of ISM model and examine the consistency of the model. The ISM – AHP integrated model & its findings provide important guidelines to tackle various barriers on a priority basis to ensure efficiency of outbound logistics of industry. The results obtained with the help of ISM are being used to gain insights into the driver and dependence power of variables (barriers) in outbound logistics coordination.

This study was mainly confined to the outbound logistics of five rubberwood processing companies in Kerala. This can be extended to other rubberwood processing industries of Kerala. The results of the study can be applied to analysing the outbound logistics of any similar companies, which is to be considered as the major scope this work.

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