

# APPLICATION OF INTERPRETIVE STRUCTURAL MODELING (ISM) FOR THE EVALUATION OF SUSTAINABILITY ISSUES IN THE TEA-SECTOR OF ASSAM

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## ABSTRACT

*Tea is one of the most popular drinks in the world since ancient times and Assam tea is a globally renowned variety of tea .For many decades, sustainability has been a major concern for the tea industry present in Assam. The research mainly focuses on the prioritization of sustainability issues present within the tea-sector of Assam. The sustainability issues concern a complex system taking into consideration the Social, Environmental and Economic factors based on literature and in consultation with workers and industrial experts of the tea sector of the state . The Interpretive Structural Modeling (ISM) qualitative analysis has been used to understand the mutual influences amongst the Sustainability issues in the tea sector of Assam by survey. The study seeks to identify which issues are the most dominant and the results draw attention of the stakeholders for the promotion of sustainability on a larger and improvised scale.*

## I. INTRODUCTION

Tea is an ancient beverage and the second most popular drink in the world after water and the cultivation of Tea is confined only to certain specific regions of the world due to specific requirements of climate and soil.. Since long Assam has been recognized as a dominant player in the international tea market among all the tea producing states of India. The first discovery of the tea plant growing in India was found in Upper Assam back in 1821, hence becoming the first tea growing state of India. The first tea garden was opened in 1835 at Lakhimpur district of Assam. The most notable development of the tea sector of the state is the participation of young unemployed youth as small tea growers, as a result leading to an increase in production of tea in the state. [1] In Assam tea is considered to be the most important crop. Some of the finest teas in the world are produced in the state. Assam produces 618,140 tonnes of tea(source: Tea Board Of India), almost 51 percent of the total tea produced in the country and also engages nearly 17 percent of the work force present in the state . The Tea industry of Assam is almost 180 years old. The industry has an important role to play in the state economy as well as in the national economy. In the present day scenario, Assam tea has maintained its international standard and also commands significant share in the world market. The Assam tea industry gives an average daily employment to more than six lakh persons in the state, which nearly accounts for 50 percent of the total average daily number of labours

employed by the tea industry in the country. The tea growing areas in Assam is separated into two regions, viz. Assam Valley and Cachar. The Assam Valley consists of the Brahmaputra Valley comprising the districts of Dibrugarh , Sibsagarh, Lakhimpur, Darrang, Nagaon , Kamrup , Goalpara, Karbi Anglong and North Cachar Hills districts. Among all the tea producing districts of Assam, Dibrugarh has the largest area under tea nearly about 33 percent.[2]

Like many other tropical commodity sectors all is not well in the tea industry. The areas where tea production takes place are some of the most beautiful places in the world but also some of the poorest. There happens to be a striking contrast between wide mountain panoramas with luscious green fields and the existence of miserable conditions for workers and smallholders. The production of tea is labour intensive and jobs are provided by the industry in remote rural areas. In the last few years, the tea industry in the state is under threat as the land for tea plantations have not grown much while on the other hand the work force has multiplied enormously which indicates vast surplus of labour in the tea gardens. Like many other agricultural commodities, real primary producer prices have gone down over the last few decades. The sustainability of the tea sector in the state is getting affected majorly due to the low prices. The working conditions for pickers are poor, low wages, low income and job security, discrimination along ethnic and gender lines etc. add to their miseries. The possibility for improvement of working conditions for the tea plantation workers of Assam is less as a result of absence or ineffectiveness of trade unions or they do not represent them as the workers are temporary. Apart from that, the environmental footprint of the tea sector of Assam is also considerable with reduced bio-diversity as a result of habitat conversion, high application of pesticides etc. Sustainability, defined as meeting the current needs of the present without affecting those of the future and the balance of people, planet, and profit, otherwise known as the triple bottom line, is part of the ultimate goals of sustainable development and its stakeholders. Hence, a critical analysis of the mutual relationships between the various sustainability issues viz. Social, Environmental and Economic becomes essential to promote further growth and sustainable development in the already well established and world renowned tea industry of Assam.

## **II. RESEARCH OBJECTIVE**

The primary objective of the present study is the utilization of Interpretive Structural Modeling (ISM) for the evaluation and identification of the various sustainability issues present within the tea sector of Assam. The following section presents the review of existing literature. The Sustainability issues in the Tea-Sector of Assam are discussed in Section 4. The model for ISM and methodology is proposed in Section 5. In the final two sections the results and discussions are present and conclusions are drawn in the final section.

## **III. REVIEW OF EXISTING WORK**

### **3.1. Sustainability**

Lung and Levrat (2014) in their study have discussed the requirements of advance maintenance services for the promotion of sustainability.[3]

Ding et al. (2014) did a case study of the Hubei Province of Central China, for measurement of regional sustainability by the use of of a coordinated development model of economy, society and economy and

environment. Their result showed that the coordinated development index of Hubei province stayed at a poor level for the seven years of investigation. In spite of the fact that the coordinated development index was consistently increasing, the average speed of sustainable development was very slow.[4]

Bilge et al. (2014) presented a model-based approach for the assessment of value creation for enhancing sustainability in manufacturing. They concluded that the results show a positive relation between the strategic alignment value and sustainability value.[5]

Mani et al. (2014) employed AHP methodology for the determination of supplier selection using social sustainability in India. In their study many social sustainability criteria were identified through the Delphi process and the AHP model helped the supply chain managers in socially sustainable supplier selection. In their model relevant and essential social parameters were used to prioritize the suppliers.[6]

### **3.2. Interpretive Structural Modeling (ISM)**

Hansen et al. (1979) developed three broad steps for the development of an interpretive structural model. In the first step, ISM begins with an issue or problem. Secondly, the elements that comprised the issue context have been identified and listed. Finally in the last step, pairs of elements have been compared either graphically or in a relation matrix using a contextual relationship, which is mostly a verb or a verb phrase.[7]

Porter et al. (1980) have explained that ISM in the form of matrix depicts a directed (causality direction) graphic representation of a particular relationship among each pair of elements in a set, which helps in structuring a complex issue area.[8]

Anderson et al. (1994) have highlighted the utility of ISM further as the representation of a problematic situation as it captures the richness and the variety of complex phenomena.[9]

Nelson et al. (2000) have described the Interpretive Structural Modeling approach in a different way, their study shows it is relatively more efficient (in some cases) and lends itself to being replicated more effectively.[10]

Sharma et al.(2011) analysed the barriers for reverse logistics from an Indian perspective applying ISM methodology. Their work helped to identify the hierarchy of actions to be taken for handling different barriers hindering the implementation of reverse logistics.[11]

Chandramowli et al. (2011) analysed the barriers to development of land-filling communities by the use of ISM. Their paper highlights the potential of using such techniques to understand and analyze urban planning issues.[12]

Satapathy et al. (2012) used ISM approach for evaluation of the important aspects of customer's satisfaction in service quality of E-electricity utility service.[13]

Mathiyazhagan et al. (2013) employed the ISM methodology for the barrier analysis in implementing green supply chain management. The Interpretive Structural Modeling (ISM) qualitative analysis was used to understand the mutual influences amongst the twenty-six barriers by survey.[14]

## **IV. SUSTAINABILITY ISSUES**

### **4.1. Social Issues**

#### **4.1.1 Wages are low**

The large tea plantations of the state throughout the decades have benefited from low cost local or migrant labourers. The wage levels are often very low, and in smallholder gardens they get paid at much lower rates than at the estates. The wage rates of tea garden workers are fixed through a bipartite agreement between the representatives of employers and the employees of the tea gardens under the plantation labour act (for estates).

#### **4.1.2 Health & Safety Issues Along With Housing Problems**

The art of tea-plucking is a tedious and hazardous job. Workers are on their feet for hours bearing the load of the tea baskets on their shoulders as a result, back problems are common. Additionally they are exposed to pesticides, mosquitoes, other insects and poisonous snakes which pose a great threat to their health and safety. The low literacy rate and deprived health status among workers are major constraints in providing them access to major health, educational and development initiatives and programmes of the state government. Workers in the large tea estates are generally permanent but in some cases they may be of temporary nature as a result of which they are provided housing facilities in the plantation as long as they work there. Living conditions in many plantations have been found to be poor and unsanitary. Workers in tea gardens of Assam are often isolated from mainstream society and interaction with mainstream society is very low

#### **4.1.3 Discrimination on Various Grounds**

The majority of the workers in the tea plantations of Assam are from migrant, marginal and tribal communities. The total population of the tea tribes community is nearly 6 million which is 20 percent of the total population of the state[15]. Discrimination on grounds of ethnicity and gender can be commonly seen in the plantations. Women are preferred on tea estates, as they are considered better pickers and are more docile and bonded to the tea tea plantations (child/family care). They have often had very little education, but they have the skills for picking tea leaves, handed down by the previous generations so they agree to working in the field accepting the very low wages.

#### **4.1.4 Labour Casualisation and Child Labour Issues**

Tea gardens of Smallholder type depend mostly on casual( and family) labour .Casualisation of labour is a major concern as workers are not guaranteed job security and other benefits which benefit the permanent workers such as access to medical care for children. Use of child labour in Tea-sector is a common practice worldwide. As a result of financial needs and lack of education facilities, women plantation workers are often required to take their children to the tea plantations. Although efforts are made to eradicate child labour nationally (through various government initiatives) it is highly unlikely that child labour has completely vanished from the tea plantations altogether.

#### **4.1.5 Worker Representation**

Inspite of the well organized workers of the tea plantations of Assam, there exists strong rivalry between the various unions on the tea plantations, which is highly disadvantageous for the workers. Unrest of labour is not always sustained and turns out to be beneficial for the management. Since plantation workers often originate from specific ethnic, tribal and/or lower caste groups, their position becomes very vulnerable.

## **4.2. Environmental Issues**

### **4.2.1 Energy Utilization**

Tea processing is an energy intensive industry. Withering, drying, grading and packing tea requires considerable amount of energy nearly 4-18 kWh per kg of tea produced. Various types of feedstock and energy sources such as firewood, oil, natural gas, electricity, are put into use. The environmental impact of tea processing depends on factor such as the use of renewable/renewed feedstock and the energy efficiency of the machinery. Drying, the most energy-intensive phase of tea processing, is mainly carried out using firewood from natural forests as a result of which extensive deforestation occurs.

### **4.2.2 Conversion of Habitat**

One of the major environmental issues relating to the tea production in the state is habitat conversion. The main reason behind such occurrence is that the habitat for cultivation is mostly located in more rugged and remote areas which possess biodiversity of the highest order. Conversion of habitats leads to the reduction of species and due to presence of sloping land considerable soil loss occurs before the plantations are fully established. Even after well establishment of the tea plantations rate of soil erosion can be high.

### **4.2.3 Use of Agrochemicals**

Use of a variety of agrochemicals throughout the growing cycle of tea in the plantations is a common practice in order to protect tea bushes and to enhance productivity. The application of agrochemicals that are listed as hazardous and toxic has negatively affected the local and wider environment: (severely) reduced soil biodiversity. Some tea gardens also use pesticides which are banned in developed countries.

## **4.3. Economic Issues**

### **4.3.1 Diminishing Prices**

The cost of production of made tea has increased due among other things to increasing fuel prices and increased labour costs, however real retail prices over the last two decades have remained constant. In other words, while the real cost of tea has remained the same for consumers, sourcing costs for retailers and packers have gone down, as has the income for producers.

### **4.3.2 Non-uniform Value distribution and buying power concentration**

The value chain in tea comprises all the stages from green leaf production through conversion into a bulk packaged product available for blending and sale to consumers. Value addition takes place for the tea leaves at each stage of the supply chain, each with associated costs which includes the cost of plucking and sorting, factory packing, internal transport, warehousing, sales charges (auction and direct), freight, insurance, interest, blending and packaging and retailers' sales costs. The downstream stages which include blending, packaging and marketing are the most profitable and this part of the value chain is under the control of a handful of multinational tea packers and brokers, who considerably influence world retail and producer prices. There is a great deal of concentration on the

buying front. A handful of companies share domination of trade and retail sales. As auction prices are reference prices for private sales, lower auction prices result in lower prices in private/direct sales.

## V. DESIGN OF RESEARCH AND MEASURES

Data collection was primarily conducted by physical interviews with around 350 workers belonging to various Tea estates of Assam. Additionally, Industry experts were consulted by telephonic conversations and via e-mails. The Sustainability Issues which deeply affected them were finally identified after categorization of the points they mentioned under broad headings. Surveys with questionnaires related to Sustainability issues in the Tea sector of Assam were also conducted in many cases linguistic barriers existing among various tea tribes in the tea gardens of Assam did not pose a problem. Hence, measures were taken to obtain valid, reliable and relevant information useful for the research.

## VI. RESULTS AND DISCUSSION

### Interpretive Structural Modeling

Interpretive Structural Modeling first proposed by J. Warfield (1973) is a computer- assisted interactive learning technique which finds its application in the identification and summarizing a relationship among specific variables which enables individuals or groups to develop a map of the complex relationships among various elements .[16] The fundamental idea behind ISM is the use of experts' knowledge and experience for the fragmentation of a complicated system into several sub-systems (elements) and construction of a multi-level structural model. It is a very useful tool for the provision of fundamental understanding of complex situations, and to formulation a course of action for solving a problem.

The Notable Characteristics of ISM are:

- (a) It is an interpretive process because the judgement of the group decides whether and how various elements are related.
- (b) Mutual relationship is the basis of the structure as the overall structure is extracted from the complex set of elements.
- (c) ISM is a modeling methodology, as the specific relationships and overall structure is presented in a digraph model.
- (d) The complexity of relationships among various elements of the system gets proper order and direction.

The steps involved in ISM are as follows:

1. Identification of the elements related to the problem by literature review, survey and expert opinion.
2. Establishment of a contextual relationship between the identified elements on the grounds of which pairs of elements would undergo examination.

In this study ISM was applied to thirteen items which are as follows:

- Low Wages
- Health & safety issues along with housing problems
- Discrimination on various grounds
- Labour casualization and child labour issues
- Worker Representation
- Energy Utilization
- Conversion of habitat
- Use of Agrochemicals
- Diminishing prices.
- Non-uniform value distribution and buying power concentration

3. Development of a Structural Self-Interaction Matrix (SSIM) of the elements which will indicate the pair-wise relationship between elements of the system. For the Structural Self Interaction Matrix(SSIM), four symbols have been put into use for denoting the directional relationship between the criterion (i and j) which are:

V: relation from element i to element j and not in both directions.

A: relation from element j to element i and not in both directions.

X: for both directional relations from element i to j and element j to i.

O: relation between elements are not valid.

**TABLE 1: Structural Self Interaction Matrix (SSIM) For Sustainability Issues.**

SUSTAINABILITY ISSUES	I10	I9	I8	I7	I6	I5	I4	I3	I2
I1	O	V	O	O	O	O	O	A	A
I2	V	O	V	O	V	A	V	A	
I3	V	O	V	O	V	A			
I4	O	O	A	A	A				
I5	X	A	V	O					
I6	V	A	V	O					
I7	V	O	O						
I8	V	O							
I9	O								

4. Development of a reachability matrix from the SSIM and checking the matrix for transitivity.

The Structural Self Interaction Matrix gets transformed into a binary matrix, called Initial Reachability Matrix by substitution of V, A, X, and O by 1 and 0 as per the case. The rules for the substitution of 1s and 0s are as follows:

- If the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
- If the (i, j) entry in the SSIM is A, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
- If the (i, j) entry in the SSIM is X, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1.
- If the (i, j) entry in the SSIM is O, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.
- Final Reachability Matrix is obtained with the basic assumption in ISM of transitivity of the contextual relation which states if element P is related to Q and at the same time Q is related to R, then P is also related to R.

**TABLE 2. Initial Reachability Matrix.**

Sustainability Issues	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
<b>I1</b>	1	0	0	0	1	1	0	0	1	0
<b>I2</b>	1	1	0	1	1	1	0	1	1	1
<b>I3</b>	1	1	1	1	1	1	0	1	1	1
<b>I4</b>	0	1	1	1	1	0	0	1	0	1
<b>I5</b>	1	1	1	1	1	1	0	1	0	1
<b>I6</b>	0	0	0	1	1	1	0	1	0	1
<b>I7</b>	0	0	0	1	1	0	1	0	0	1
<b>I8</b>	0	0	0	1	1	0	0	1	0	1
<b>I9</b>	0	1	1	1	1	1	0	1	1	1
<b>I10</b>	0	1	1	0	1	0	0	1	0	1



**TABLE 3. Final Reachability Matrix**

Sustainability Issues	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	DRIVING POWER
<b>I1</b>	1	0	0	0	1	1	0	0	1	0	<b>4</b>
<b>I2</b>	1	1	0	1	1	1	0	1	1	1	<b>8</b>
<b>I3</b>	1	1	1	1	1	1	0	1	1	1	<b>9</b>
<b>I4</b>	0	1	1	1	1	0	0	1	0	1	<b>6</b>
<b>I5</b>	1	1	1	1	1	1	0	1	0	1	<b>8</b>
<b>I6</b>	0	0	0	1	1	1	0	1	0	1	<b>5</b>
<b>I7</b>	0	0	0	1	1	0	1	0	0	1	<b>4</b>
<b>I8</b>	0	0	0	1	1	0	0	1	0	1	<b>4</b>
<b>I9</b>	0	1	1	1	1	1	0	1	1	1	<b>8</b>
<b>I10</b>	0	1	1	0	1	0	0	1	0	1	<b>5</b>
<b>DEPENDENCY</b>	<b>4</b>	<b>6</b>	<b>5</b>	<b>8</b>	<b>10</b>	<b>5</b>	<b>1</b>	<b>8</b>	<b>4</b>	<b>9</b>	

5. The reachability matrix is then partitioned into different levels. From the final reachability matrix, the reachability and antecedant set for each issue is found out. The reachability set comprises of criteria for itself as well as others which it may help to achieve on the other hand, antecedent set consists of itself and other criterion which helps in achieving it. The intersection set is subsequently derived and the variables having reachabilty and intersection sets same are provided the top level in ISM hierarchy.

**TABLE 4. Partition Of Reachabilty Matrix: Iteration 1**

Issues	Reachability Set	Antecedent Set	Intersection Set	Level
<b>I1</b>	1,5,6,9	1,2,3,5	1,5	<b>I</b>
<b>I2</b>	1,2,4,5,6,8,9,10	2,3,4,5,9,10	2,4,5,9,10	
<b>I3</b>	1,2,3,4,5,6,8,9,10	3,4,5,9,10	3,4,5,9,10	
<b>I4</b>	2,3,4,5,8,10	2,3,4,5,6,7,8,9	2,3,4,5,8	
<b>I5</b>	1,2,3,4,5,6,8,10	1,2,3,4,5,6,7,8,9,10	1,2,3,4,5,6,8,10	
<b>I6</b>	4,5,6,8,10	1,2,3,5,6,9	5,6	
<b>I7</b>	4,5,7,10	7	7	
<b>I8</b>	4,5,8,10	2,3,4,5,6,8,9,10	4,5,8,10	<b>I</b>
<b>I9</b>	2,3,4,5,6,8,9,10	1,2,3,9	2,3,9	<b>I</b>
<b>I10</b>	2,3,5,8,10	2,3,4,5,6,7,8,9,10	2,3,5,8,10	<b>I</b>

**TABLE 5. Partition Of Reachabilty Matrix: Iteration 2**

Issues	Reachability Set	Antecedent Set	Intersection Set	Level
<b>I1</b>	1,6,9	1,2,3	1	<b>II</b>
<b>I2</b>	1,2,4,6,9	2,3,4,9	2,4,9	
<b>I3</b>	1,2,3,4,6,9	3,4,9	3,4,9	
<b>I4</b>	2,3,4	2,3,4,6,7,9	2,3,4	
<b>I6</b>	4,6	1,2,3,6,9	6	
<b>I7</b>	4,7	7	7	
<b>I9</b>	2,3,4,6,9	1,2,3,9	2,3,9	

**TABLE 6. Partition Of Reachabilty Matrix: Iteration 3**

Issues	Reachability Set	Antecedent Set	Intersection Set	Level
<b>I1</b>	1,6,9	1,2,3	1	<b>III</b> <b>III</b>
<b>I2</b>	1,2,6,9	2,3,9	2,9	
<b>I3</b>	1,2,3,6,9	3,9	3,9	
<b>I6</b>	6	1,2,3,6,9	6	
<b>I7</b>	7	7	7	
<b>I9</b>	2,3,6,9	1,2,3,9	2,3,9	

**TABLE 7. Partition Of Reachabilty Matrix: Iteration 4**

Issues	Reachability Set	Antecedent Set	Intersection Set	Level
<b>I1</b>	1,9	1,2,3	1	<b>IV</b>
<b>I2</b>	1,2,9	2,3,9	2,9	
<b>I3</b>	1,2,3,9	3,9	3,9	
<b>I9</b>	2,3,9	1,2,3,9	2,3,9	

**TABLE 8. Partition Of Reachability Matrix: Iteration 5**

Issues	Reachability Set	Antecedent Set	Intersection Set	Level
I1	1	1,2,3	1	V
I2	1,2	2,3	2	
I3	1,2,3	3	3	

**TABLE 9. Partition Of Reachability Matrix: Iteration 6**

Issues	Reachability Set	Antecedent Set	Intersection Set	Level
I2	2	2,3	2	VI
I3	2,3	3	3	

**TABLE 10. Partition Of Reachability Matrix: Iteration 7**

Issues	Reachability Set	Antecedent Set	Intersection Set	Level
I3	3	3	3	VII

6. Development of ISM Model: A digraph is drawn shown in **Fig. 1** and removal of the transitive links based on the relationships given in the reachability matrix takes place. Conversion of the resultant digraph into an ISM-based model occurs by replacement of the elements nodes with statements. The digraphs drawn are complex in nature. The level I barriers are assigned the top level in the hierarchy as they won't help any other issues to achieve. The barriers having same level are kept on the same level of hierarchy. The model is finally reviewed for conceptual-inconsistency check and final modifications are applied.

7. MICMAC Analysis: In an ISM model the relationships found are tested by MICMAC Analysis in which the enablers get classified into four categories shown in **Fig. 2**. The main motive behind the analysis is to analyze the driver power and dependence of variables that influence the Tea Sector of Assam with respect to Sustainability.

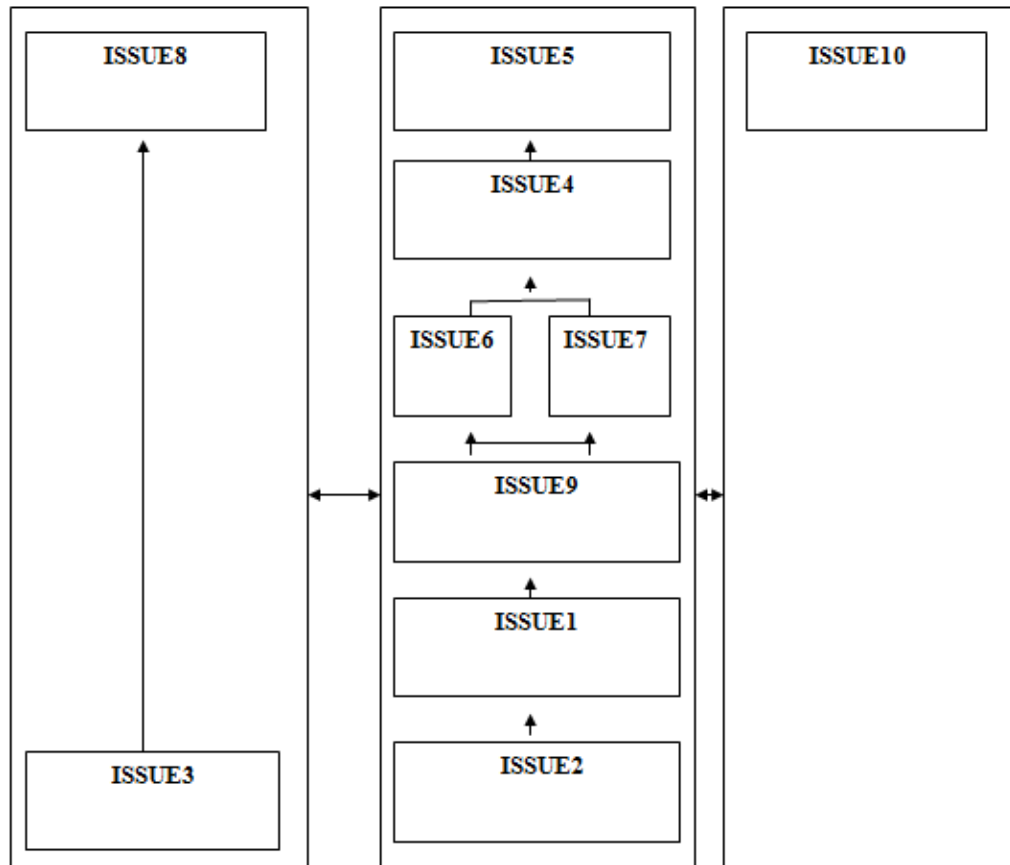


FIG. 1 Ism Based Model For Sustainability Issues In The Tea Sector Of Assam

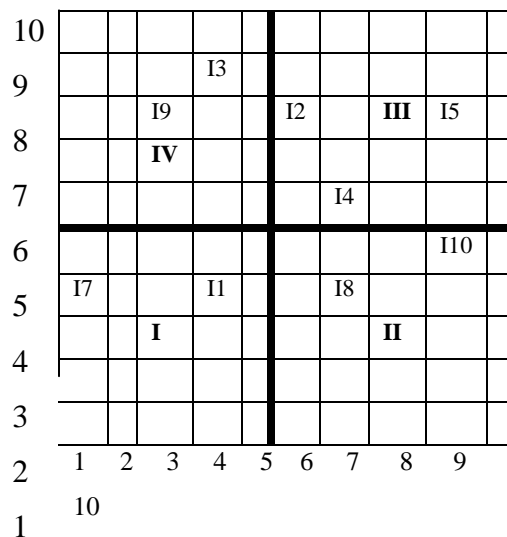


Fig. 2 Driver Power and Dependence Diagram

The four clusters into which enablers are classified in this method are-

- a) Cluster I: Weak driving power and weak dependence-This group is also known as Autonomous or Excluded Enablers.
- b) Cluster II: Weak driving power and strong dependence- This group of enablers are called as Depending Enablers
- c) Cluster III: Strong driving power and strong dependence- These enablers are simultaneously very influent and very dependent.
- d) Cluster IV: Strong driving power and weak dependence- Enablers in this group are altogether very influent and little dependent.

## VII. CONCLUSION

The proposed methodology in this particular research helps in the identification of the hierarchy of actions to be implemented for dealing with the sustainability issues faced by the workers in the tea sector of Assam. Some of the sustainability issues have been identified and put into the ISM model for the analysis of interaction between them. The driver dependence diagram provides with much valuable insight regarding the relative importance and interdependencies among the sustainability issues. From Fig.2. it can be clearly visualised that discrimination on various grounds and diminishing prices are the driver variables which are Issues 3 and 9 while on the other hand low wages and conversion of habitat are autonomous barriers namely Issues 1 and 7. These issues are termed as autonomous because they have very few links with the system and are to some extent out of line with the system. Sustainability issues such use of agrochemicals and non-uniform value distribution and buying power concentration have a weak driving power, but show strong dependency on other issues. This is the indication that all other issues are required to come together for overcoming the threats related to sustainability issues in the tea sector of Assam. Issues such as health & safety issues along with housing problems, worker representation and labour casualization act as linkage variables. They possess strong driver power as well as strong dependency power. These enablers should be studied with greater attention than the others. From the analysis it can be concluded that three issues discrimination on various grounds and diminishing prices act as Independent enablers possessing the maximum driving power. It can be further concluded that these variables are the key issues of sustainability in the tea sector of Assam.

The Tea sector of Assam is facing many more new challenges in the field of Sustainability due to market changes and other environmental reasons hence there is a greater requirement of development of new models to keep a check on the issues affecting the sustainability of the precious industry of the nation. The ISM model proposed in this research for the identification of sustainability issues in the tea sector of Assam can also be translated to other sectors belonging to diverse fields for further promotion of sustainable development in the country. The model suggested will provide authorities with a realistic representation of the problem in the course of successful implementation of Sustainable development.

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## REFERENCES

- [1] S. Roy, Historical Review of Growth of Tea Industries in India: A Study of Assam Tea, International Conference on Social Science and Humanity IPEDR vol.5, Singapore, 2011, 166-170
- [2] N. Arya, Growth and Development Of Tea Industry in Assam, International Journal of Scientific & Engineering Research, 4(7), 2013,
- [3] J.V. Hansen, L.J. Mckell, L.E. Heitger ISMS: computer-aided analysis for design of decision-support systems, Management Science, 25(11), 1979, 1069–1081.
- [4] B. Iung, E. Levrat, Advanced Maintenance Services for Promoting Sustainability, Procedia CIRP, 22, 2014, 15-22.
- [5] Y. Ding, B. Vries, Q. Han, Measuring regional sustainability by a coordinated development model of economy, society, and environment: A case study of Hubei Province, Procedia Environmental Sciences, 22, 2014, 131-137.
- [6] P. Bilge, F. Badurdeen, G. Seliger, I.S. Jawahir, Model-based approach for assessing value creation to enhance sustainability in manufacturing, Procedia CIRP, 17, 2014, 106-111.
- [7] V. Mani, R. Agrawal, V. Sharma, Supplier selection using social sustainability: AHP based approach in India, INTERNATIONAL STRATEGIC MANAGEMENT REVIEW, 2, 2014, 98-112.
- [8] A.L. Porter, F.A. Rossini, S.R. Carpenter, A.T. Roper (1980), A guide book for technology assessment and impact analysis, vol 46. North Holland series in system science and engineering, Elsevier, New York.
- [9] Nelson K, Nadkarni S, Narayanan VK, Ghods M (2000) Understanding software operations support expertise: a revealed causal mapping approach, Management Information System Q J, 24(3), 475–507.
- [10] J.C. Anderson, M. Rungtusanthanam, R.G. Schroeder A theory of quality management underlying the Deming management method. Academy Of Management Review, 19(3), 1994, 472–509.
- [11] V. Anantmula, S. Kanungo Establishing and structuring criteria for measuring knowledge management. In: Proceedings of the 38th Hawaii international conference on system sciences, 26, 2005.
- [12] S.K. Sharma, B.N. Panda, S.S. Mahapatra, S. Sahu Analysis of Barriers for Reverse Logistics: An Indian Perspective, International Journal of Modeling and Optimization, 1(2), 2011, 101-106.
- [13] S. Chandramowli, M. Transue, F.A. Felder, Analysis of barriers to development in landfill communities using interpretive structural modeling, Habitat International, 35(2), 2011, 246-253.
- [14] S. Satapathy, S.K. Patel, A. Biswas, P. Mishra, Interpretive structural modeling for E-electricity utility service Service Business An International Journal, 6(3), 2012, 349-367.
- [15] K. Mathiyazhagan, K. Govindan, A. NoorulHaq, Y. Geng, An ISM approach for the barrier analysis in implementing green supply chain management, Journal of Cleaner Production, 47, 2013, 283-297.
- [16] Tea Tribes, [http://en.wikipedia.org/wiki/Tea\\_tribes](http://en.wikipedia.org/wiki/Tea_tribes), Last accessed on January 12, 2015.

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