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Factors Analysis of ISCM Benchmarking Using DEMATEL Technique

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Abstract

The present competitive scenario requires high degree of sophistication in the benchmarking practice that helps to improve the performance of internal supply chain management (ISCM) of any organization. Thus, it is necessary to analyze effectively the factors of ISCM benchmarking. The present study deals with the identification of factors of ISCM using literature survey. The influence between the identified factors was evaluated through brainstorming as well as decision making trial and evaluation laboratory [DEMATEL] technique. The internal assessment of factors is decided on the basis of 5 point rating scale, where 0 point indicates less influence of factor, while 5 point indicates high influence of factor. The main goal of this research work is to perform factor's analysis and finally classify them into cause and effects groups using DEMATEL technique. This research work might be fruitful for researchers as well as managers to identify those factors which are responsible for cause and effect of problem in any type of business.

Keywords: DEMATEL Technique, Factor Analysis, Benchmarking Practice, ISCM, Matrix Calculator

Introduction

The manufacturing industries have to deal with number of factors in order to satisfy customer demand offering them with best quality product in minimum possible cost and time. However, the market is flooded with number of production units for a single product providing customer to choose best alternative for their demands (Dangayach, G.S. & Deshmukh S. G., 2006). Therefore, the manufacturing industries require benchmarking practice of ISCM to be implemented in their system to improve its functioning. The recent ISCM system, allow the industry to make internal changes without enhancing the operating cost. Singh, R. K. (2011) derived a framework using interpretive structural modelling (ISM) to improve supply chain coordination. Manufacturing industries deals in purchase, production and distribution of those goods that are generally consumed at regular interval of time. The strength of every manufacturing industry lies in the existence of production, purchasing, distribution network with low operating cost. However, the flexibility of supply chain and manufacturing system with the emergence of various new concepts and models to make better system is required. Manufacturing industries incessantly find different ways to improve their flexibility and responsiveness in terms of competition by changing their operations strategy, methods and technologies (Gunasekaran, A. & Ngai, E. W. T. 2004). International market competition, reduce the durability of existing products, while on the other hand increase the customer expectations, etc. This concept should always enforced business agencies to invest more on ISCM benchmarking for its improvement. The variable lifestyle and advancement of constant communication technology should bring constant renovation and motivation for improvement of internal supply chain. In every type of manufacturing industry, optimization of supply chain process always need proper coordination among different members and departments as shown in figure 1. The objective of ISCM is to control and coordinate all the activity of purchase, production and distribution sections, which involve suppliers (S1, S2…Sn) and customers (C1, C2….Cn) (Kailash, Saha, R. K. & Goyal, S. 2017a).

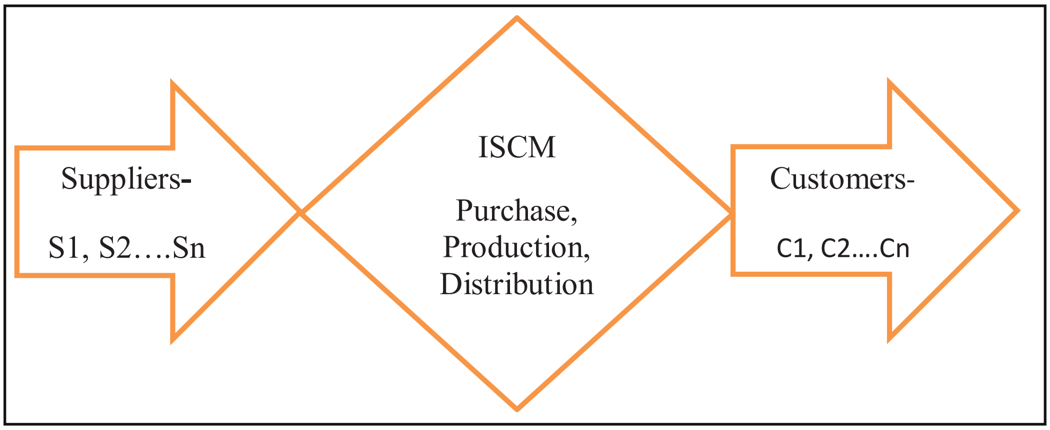

Fig. 1: Optimization of ISCM of Manufacturing Industries

Internal supply chain activities must be based on designed, planned and organized framework. An effective evaluation system should provide a benchmark for internal supply chain system (Shaw, S. et al. 2010). ISCM benchmarking practices would be helpful in the identification of performance gap and appropriate punctual performance assessment (Kailash, Saha, R. K. & Goyal, S. 2017b). A number of interrelated standards play an important role on customer satisfaction while improving the performance of ISCM. In the present study, authors have come across fifteen factors of ISCM benchmarking from the existing literature (Kailash, Saha, R. K. & Goyal, S. 2017c), their inter relationship and influence among factors have established using DEMATEL technique.

Literature Review

The concept of supply chain management (SCM) was introduced in early decade of 1980 with subsequent development of the academic knowledge in the area of relevance (Stefanovic, N. & Stefanovic, D. 2011). Hessami, Z. H. & Savoji, A. (2011) proposed risk management in supply chain. SCM is a strategic change in organizational dominant culture and principles by which the foreign partners set some optimal activities in their organizational agenda to reach a joint objective (Meehan, J., & Muir, L. 2008). Chaghooshi, A. J., et al. (2012) applied a new integration of MCDM (Multi criteria decision making) techniques for supplier selection in supply chain. Effectiveness is a domain which meets the customer's needs while efficiency measures the quality of economic usage of organization's resources (Neely et al. 1995). Supply performance assessment can be divided into two measures of qualitative and quantitative methods. Business incorporations and universities more often use the quantitative method. This method suffers from two major problems: First is associated with the amount of time required for data collection and the other describes the method to obtain reliable information for data assessment (Foggin et al. 2004). Kumar, P., et al., (2008) prepared a hierarchy for flexibility of supply chain dimensions using ISM to know their influence over each other in global supply chains. Soon, Q. H. & Udin, Z. M. (2011) made an attempt to investigate SCM practices related to flexibility, value chain, capabilities and find that all the organization enhanced their manufacturing flexibility components with supply and logistic networks in order to gain benefits. Stevenson, M. & Spring, M. (2009) proposed inter firm empirical study on supply chain flexibilities and found inter organizational aspects, their interaction with one another within industry. ISCM is a long term orientation and inside company integration, which includes either combining or mediating collaborative relationship (Kotzab, H. et al. 2011). In general, internal supply chain consists of two or more departments, which are formally separated from each other but are attached through the flow of materials, information and finance (Kailash, Saha, R. K. & Goyal, S. 2017d). Internal supply chain is the network of manufacturing industry, where one decisions have direct impact on all other decisions (Kailash, Saha, R. K. & Goyal, S. 2015). Singh, R. K. & Acharya, P. (2013) proposed a theoretical framework of supply chain flexibility; they extracted 22 flexibility dimensions from existing literature and made them fit into a broader framework. Sadeh, E. et al. (2011) presented a framework to study linkages among TQM practices, SCM practices, and performance using DEMATEL technique.

ISCM Benchmarking Factors

On the basis of literature, authors have identified fifteen direct and indirect factors of benchmarking of ISCM which are further explained in brief:

Human Resources Orientation

Human resource is an orientation process through which an employee acquires the necessary skills, knowledge, behaviours, training, which effectively transit into a new organization (Abdullah, H. 2009). It includes the following functions: recruitment and selection, maintaining good working conditions, managing employee relations and training & development (Chen, X. 2010; Vemic, J. 2007).

Inbound Logistics

Inbound logistics is an integral element of business operations for a manufacturing industry. It should involve the processes of receiving, storing and distributing raw materials for use in production (Svensson, G. 2002; Liu, X. & Sun, Y. 2011; Maleki, R. A. & Reimche, J. 2011; Kwateng, K. O. et al. 2014).

Operational Logistics

It is the flow of goods, information and money throughout a manufacturing industry encompassing aspects of finance, marketing, accounting and gives an expanded view of industry operations (Cowling, P. 2002; Wang, C.X. & Webster, S. 2007; Bertelsen, S. & Nielsen, J. 1997; Gram, M. 2013).

Outbound Logistics

It control the movement of material associated with storing, transporting, and distributing goods to its customers. It refers specifically to the planning and implementation of the distribution of goods to consumer (Tilokavichai, V. et al. 2012).

Economics of Scale

Economics of scale is the cost rewards that enterprises obtain due to size, output, or scale of operation, with cost per unit of output generally decreasing with increasing scale as the fixed costs are spread out over more units of output (Hanson, O. Y. 2015; Sheu, J. B. 2007; Anwar, R. S. & Ali, S. 2015).

Flexibility

A flexible supply chain organization requires flexibility at all levels (strategic level, operational level and tactical levels), customer demands and supply (Wang, Y.C. 2008; Grigore, S. D. 2007; He, Y. T. & Down, D.G. 2009; Jayant, A. & Ghagra, H.S. 2013; Kesavan, S. 2014; Sanchez, A. M. & Perez, M. 2005).

Logistics Strategies

Logistics strategy is the set of guiding principles, driving forces that help to coordinate goals, plans and policies between partners across a given supply chain (Rushton, A. & Saw, R. 1992; Scott, C. & Westbrook, R. 1991; Rodrigue, J. P. 2006; Lin, Y. et al.2012; Ramaa, A. et al. 2012; Gu, J. et al. 2007).

New Product Development System

Product development may involve modification of an existing product, its presentation or formulation of an entirely new product that satisfies a newly defined customer demand (Senk, M. K. et al. 2010; Abdul Adis, A. A. & Jublee, E. 2010). The creation of products with different characteristics are offer new or additional benefits to the customer (Pattikawa, L. H. et al. 2006; Murthy, D.N.P. 2007; Murthy, D.N.P. 2006).

Material follow up and Procurement

It is to control the manufacturing activities by obtaining the progress status of issued orders and delayed orders (Agboyi, M. R. et al 2015; Lenin, K. 2015; Grosso, M. G. & Shepherd, B. 2011; Angkiriwang, R. et al. 2014).

Production Operation Process

It deals with decision related to production operation process so that the resulting goods and services are produced in accordance with the quantitative specifications and demand schedule with minimum cost (Tan, X.C. et al. 2011; Forza, C. 2002; Rakicevic, Z. & Vujosevic, M. 2015; Fekete, M. & Hulvej, J. 2015; Stawowy, A. & Duda, J. 2012; Pekgun, P. et al. 2008; Kaushal, A. et al. 2016; Gogi, V. S. & Badarinarayana, K.S. 2016; Kumar, S. & Raj, T. 2016).

Production Programming

The purpose of production programming is to make the balance between demand and availability of material inside the organization (Balogun, O.S. et al. 2012). Production programmer always keep the demands of customer in his mind and then check the availability of production capacity (Al-kuhali K. et al. 2012; Imam, T. & Hassan, F. 2009).

Quality System

It is a collection of business processes focusing consistently on meeting customer requirements and enhancing their satisfaction. A quality system is a structure for managing the quality of the output (Matias, J. C. D. O & Coelho, D. A. 2002).

Products Delivery

The main purpose of products delivery is to supply the right material at right place in minimum time (Chen, C. W. & Wong, V. 2012; Bhuiyan, N. 2011).

Foreign Trade and Service Management

International trade principle is not different from domestic trade. The behaviour of parties involved in a trade doesn't change fundamentally regardless of whether trade is across a border or not (Goyal, T. M. 2013). The main difference is that international trade is typically more costly than domestic trade. Industrialization, advanced transportation, globalization, multinational corporations, and outsourcing, all have a major impact on the international trade system. Increasing international trade is crucial to the continuance of globalization. Without international trade, nations would be limited to the goods and services produced within their own borders (Goyal, T. M. 2012).

Transport-Reception-Custom Decision

A transportation management system is a subset of SCM concerning transportation operations and may be part of an enterprise resource planning system. It is a fully customizable application with an event driven design that enables you to shop around for best pricing, consolidate orders, customize and run reports and audit freight bills (Eksioglua, B. et al 2009).

Internal Supply Chain Management (ISCM)

The primary objective of internal supply chain is to complete a product according to customer priorities in such a way that the concern product is produced with the highest quality with minimum price by concern time to be delivered to customers. It is an internal group of management within industry which interconnect the purchase and distribution department through production department. The main function of ISCM is to control the flow of raw material, funds and information within industry only (Kailash, Saha, R.K. & Goyal, S. 2017e).

Benchmarking

Benchmarking is a continuous Plan- Do- Check- Action comparative activity. The objective of benchmarking is to provide the information about competitors and identify best competitive factor out of all factors (Bhutta, Khurrum, S., & Huq, F. 1999). Benchmarking practice would be helpful to identify benchmarking factor followed by their utility to improve the performance of other manufacturing industries.

ISCM Benchmarking

It is a continuous practice which controls internal supply chain activity between different sections like: purchase, production and distribution by identifying internal supply chain performance gap of same capacity units within manufacturing industry. Such type of practice may be helpful in improving the performance of ISCM as well as creating benchmark for others competitors (Kailash, Saha, R.K. & Goyal, S. 2017 f).

Research Methodology

In this research work authors come across DEMATEL technique, brain storming activity as a tool and industrial expert's opinion for factors analysis. On the basis of factors influence, authors have classified variable factors into cause and effects diagram. Finally, author have identify best benchmarking factor and used them to improve the performance of other manufacturing industries.

DEMATEL Techniques

The Battelle Geneva Institute can be introduced as the origin of DEMATEL technique (Fontela, E. & Gabus, A. 1976). Basically, DEMATEL technique was used in unarranged, incompatible and opposite phenomena to reach some integrated solutions for complex problems (Shieh, J. I. &Wu, H. H. 2016). Amiri, M. et al. (2011) developed a DEMATEL method to prioritize distribution centres in supply chain. DEMATEL is able to convert the relationship between cause & effect into structural system model (Singh, R. K. & Acharya, P. 2014). DEMATEL aims to obtain direct and indirect cause and the strength of influence across quality features by applying matrix computation to complex systems and comparing the interrelations among the quality features (Lee et al. 2013). DEMATEL is a comprehensive method for constructing and analysing a structural model of the causal relationship between the factors. DEMATEL has the ability not only to demonstrate direct relationship of sub-systems, but also to clarify the degree of interactions between sub-systems (Wu, H. H. & Tsai, Y. N. 2012a). DEMATEL technique consists of the various steps as shown in figure 2. (Shieh, J. I. et al. 2010).

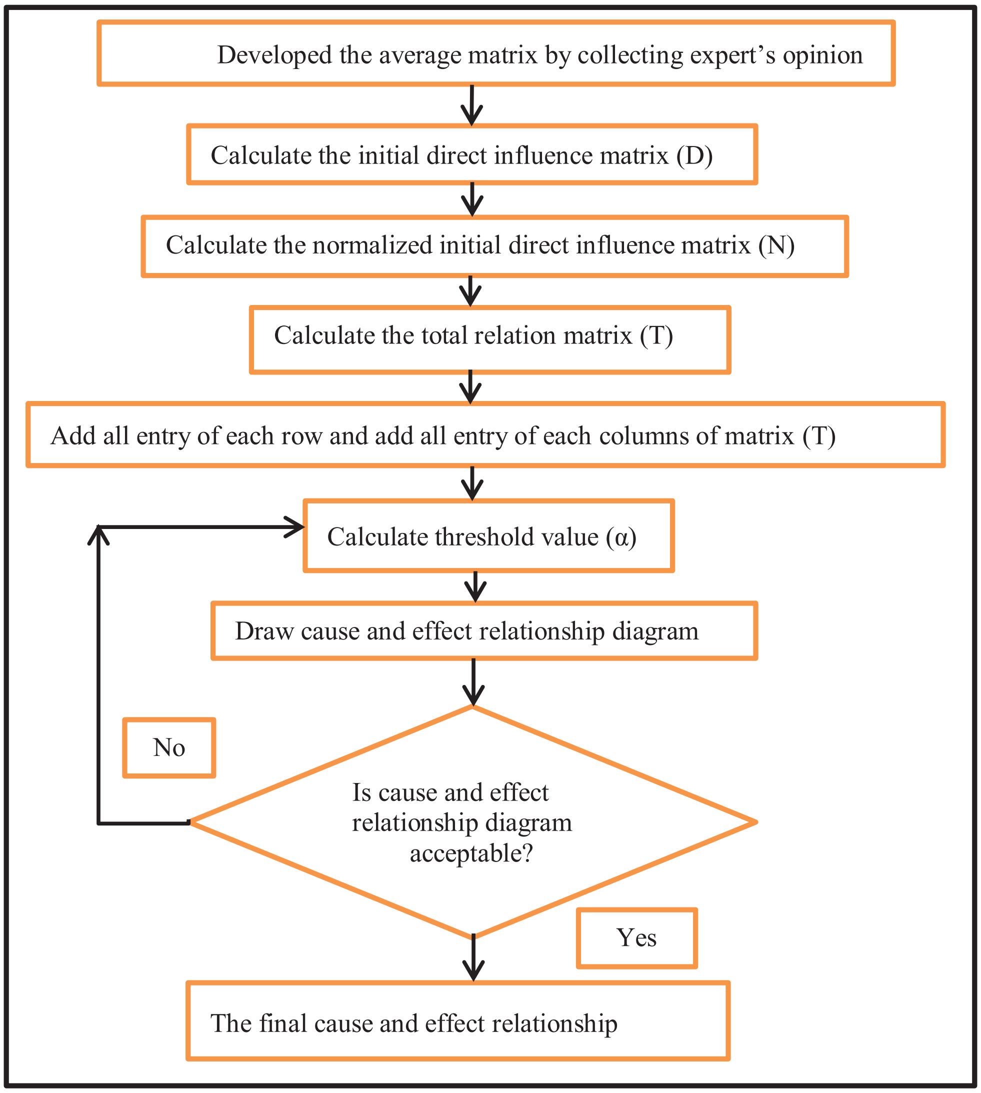

Fig. 2: DEMATEL Technique- Steps

Step 1 Calculation of the direct-influence matrix

The first step in DEMATEL is to calculate direct influence matrix with the help of expert views (Tzeng, G.H. et al. 2007). The mutual relationship among the attributes is being evaluated using a scale from 1 to 4 in ascending order (Sadeh, E. et al. 2011). Each expert is asked: 'To what degree does factor i affect factor j?' The initial direct-relation matrix D = [dij] * n is obtained through pair wise comparisons in terms of influences and directions between criteria, in which n denotes the number of experts (Shen, Y. C., et al. 2012). If there are n variables that impact the system, a direct influence matrix will look like.

$$D = \begin{bmatrix} 0 & \cdots & d1n \\ \vdots & \ddots & \vdots \\ dn1 & \cdots & 0 \end{bmatrix}$$

Here authors have used fifteen factors for evaluation of ISCM benchmarking of Indian manufacturing industries. On the basis of ranking obtained from various industrial experts, direct-influence matrix has been obtained (table 1). Table 1 shows the influence of one factor i on the other factor j and it also consist the sum of all rows as well as sum of all columns. For example: In 2nd row and 1st column of table 1 (direct influence matrix), the entry value is 1.40 indicates the influence of inbound logistics on human resource orientation. In 1st row and 9th column of table 1, the entry value 2.80 indicates the influence of human resource orientation on material follow up and procurement. Similarly, other value also indicates the influence of one factor on the other factor.

Table 1: Direct Influence Matrix

ISCM Factors	Human Resources Orientation	Inbound logistics	Operational logistics	Outbound logistics	Economies of scale	Flexibility	Logistics strategies	New Product development system	Material follow up and Procurement	Production Operation Process	Production Programming	Quality System	Products delivery	Foreign trade and service management	Transport-Reception-Custom decision	SUM
Human Resources Orientation	0.00	1.00	1.50	0.80	0.40	0.20	1.50	1.50	2.80	1.90	2.50	2.80	1.80	0.90	1.70	21.30
Inbound logistics	1.40	0.00	2.80	0.30	2.20	1.40	0.70	1.20	2.60	1.60	1.00	2.40	0.60	0.20	1.50	19.90
Operational logistics	0.90	0.20	0.00	1.50	1.80	1.30	0.30	1.60	1.40	1.70	0.90	2.40	0.70	0.00	0.60	15.30
Outbound logistics	0.70	0.10	0.10	0.00	1.70	1.00	0.30	0.00	0.90	0.10	0.00	2.30	2.60	0.10	1.70	11.60
Economies of scale	1.00	0.90	1.60	0.50	0.00	0.90	0.80	0.90	0.80	0.20	0.30	0.80	1.70	1.50	2.10	14.00
Flexibility	1.00	1.10	1.50	1.40	2.60	0.00	1.30	0.80	1.20	0.90	1.00	1.10	1.70	1.30	1.50	18.40
Logistics strategies	0.70	2.10	2.30	1.80	2.30	0.40	0.00	0.20	0.50	1.60	1.00	0.70	1.60	2.00	1.90	19.10
New Product development system	0.50	0.10	0.20	0.10	0.40	0.40	0.10	0.00	0.30	1.40	0.30	0.60	0.10	0.00	0.00	4.50
Material follow up and Procurement	1.20	2.70	1.40	1.20	1.50	0.60	0.80	0.20	0.00	2.70	1.70	1.90	0.50	0.70	1.20	18.30
Production Operation Process	1.30	0.40	1.30	1.00	0.90	1.20	0.20	0.00	0.70	0.00	2.10	2.50	0.90	0.00	0.00	12.50
Production Programming	0.70	0.10	0.70	0.40	0.30	0.40	0.40	0.00	0.30	2.00	0.00	2.30	0.30	0.00	0.00	7.90
Quality System	0.60	0.30	1.40	0.80	1.00	0.70	0.30	0.50	0.50	2.40	1.10	0.00	0.60	0.30	1.20	11.70
Products delivery	0.30	0.20	0.10	1.40	1.70	0.80	1.00	0.30	0.30	1.20	0.00	2.20	0.00	1.30	0.30	11.10
Foreign trade and service management	0.60	0.30	0.20	0.50	0.70	1.20	0.80	0.00	0.50	1.40	0.00	2.10	0.90	0.00	0.80	10.00
Transport-Reception-Custom decision	0.40	1.30	0.30	1.70	1.70	1.40	1.20	0.00	1.00	0.20	0.20	2.00	2.70	1.40	0.00	15.50
SUM	11.30	10.80	15.40	13.40	19.20	11.90	9.70	7.20	13.80	19.30	12.10	26.10	16.70	9.70	14.50	

Step 2 Normalize the direct-influence matrix

Once the direct-influence matrix has been obtained, it can be normalized by equation (1) & (2) to get the initial normalized direct influence matrix 'N' as shown in table 2. Table 2 is developed by multiplying all entries of direct influence matrix by M. The value of M can be calculated by equation 1.

$$M = \min\left[1 \div max\sum_{i=1}^{n} dij, 1 \div max\sum_{j=1}^{n} dij\right] \quad (1)$$

$$M = \min\left[1 \div 26.10,\ 1 \div 21.30\right]$$

$$\text{Normalized matrix} = D*M \quad (2)$$

Table 2: Normalize Direct Influence Matrix (N)

ISCM Factors	Human Resources Orientation	Inbound logistics	Operational logistics	Outbound logistics	Economies of scale	Flexibility	Logistics strategies	New Product development system	Material follow up and Procurement	Production Operation Process	Production Programming	Quality System	Products delivery	Foreign trade and service management	Transport-Reception-Custom decision
Human Resources Orientation	0	0.04	0.06	0.03	0.02	0.01	0.06	0.06	0.11	0.07	0.1	0.11	0.07	0.03	0.07
Inbound logistics	0.05	0	0.11	0.01	0.08	0.05	0.03	0.05	0.1	0.06	0.04	0.09	0.02	0.01	0.06
Operational logistics	0.03	0.01	0	0.06	0.07	0.05	0.01	0.06	0.05	0.07	0.03	0.09	0.03	0	0.02
Outbound logistics	0.03	0	0	0	0.07	0.04	0.01	0	0.03	0	0	0.09	0.1	0	0.07
Economies of scale	0.04	0.03	0.06	0.02	0	0.03	0.03	0.03	0.03	0.01	0.01	0.03	0.07	0.06	0.08
Flexibility	0.04	0.04	0.06	0.05	0.1	0	0.05	0.03	0.05	0.03	0.04	0.04	0.07	0.05	0.06
Logistics strategies	0.03	0.08	0.09	0.07	0.09	0.02	0	0.01	0.02	0.06	0.04	0.03	0.06	0.08	0.07
New Product development system	0.02	0	0.01	0	0.02	0.02	0	0	0.01	0.05	0.01	0.02	0	0	0
Material follow up and Procurement	0.05	0.1	0.05	0.05	0.06	0.02	0.03	0.01	0	0.1	0.07	0.07	0.02	0.03	0.05
Production Operation Process	0.05	0.02	0.05	0.04	0.03	0.05	0.01	0	0.03	0	0.08	0.1	0.03	0	0
Production Programming	0.03	0	0.03	0.02	0.01	0.02	0.02	0	0.01	0.08	0	0.09	0.01	0	0
Quality System	0.02	0.01	0.05	0.03	0.04	0.03	0.01	0.02	0.02	0.09	0.04	0	0.02	0.01	0.05
Products delivery	0.01	0.01	0	0.05	0.07	0.03	0.04	0.01	0.01	0.05	0	0.08	0	0.05	0.01
Foreign trade and service management	0.02	0.01	0.01	0.02	0.03	0.05	0.03	0	0.02	0.05	0	0.08	0.03	0	0.03
Transport-Reception-Custom decision	0.02	0.05	0.01	0.07	0.07	0.05	0.05	0	0.04	0.01	0.01	0.08	0.1	0.05	0

Step 3 Obtain total Influence Matrix

Once the normalized direct-relation matrix X is obtained, the total relation matrix T can be acquired through equation (3) as shown in table 3.Table 3 is the total influence matrix of all factors.

$$T = N+N^2+N^3+N^4+N^5+\ldots\ldots..+N^P$$

$$= N\,(I+N+N^2+N^3+N^4+\ldots\ldots..+N^{P-1})$$

$$[(I-N)\,(I-N^{-1})]$$

$$= N\,(I-N^P)\,(I-N)^{-1}$$

Then $$T= N\,(I-N)^{-1} \quad (3)$$

Where I = Identity Matrix

Table 3: Total Influence Matrix (T)

ISCM Factors	Human Resources Orientation	Inbound logistics	Operational logistics	Outbound logistics	Economies of scale	Flexibility	Logistics strategies	New Product development system	Material follow up and Procurement	Production Operation Process	Production Programming	Quality System	Products delivery	Foreign trade and service management	Transport-Reception-Custom decision	SUM
Human Resources Orientation	0.05	0.09	0.13	0.1	0.11	0.07	0.12	0.09	0.16	0.16	0.16	0.22	0.13	0.07	0.13	1.79
Inbound logistics	0.1	0.05	0.18	0.07	0.16	0.1	0.09	0.08	0.15	0.14	0.1	0.2	0.08	0.05	0.12	1.67
Operational logistics	0.07	0.04	0.05	0.1	0.13	0.09	0.05	0.08	0.09	0.13	0.07	0.16	0.07	0.03	0.07	1.23
Outbound logistics	0.06	0.03	0.04	0.04	0.12	0.07	0.04	0.02	0.06	0.05	0.03	0.15	0.14	0.03	0.11	0.99
Economies of scale	0.07	0.06	0.1	0.06	0.06	0.07	0.07	0.05	0.07	0.07	0.05	0.11	0.11	0.09	0.12	1.16
Flexibility	0.09	0.08	0.12	0.1	0.18	0.05	0.1	0.06	0.1	0.1	0.09	0.14	0.13	0.09	0.12	1.55
Logistics strategies	0.08	0.12	0.15	0.13	0.17	0.08	0.05	0.04	0.08	0.13	0.09	0.14	0.12	0.12	0.13	1.63
New Product development system	0.03	0.01	0.03	0.01	0.04	0.03	0.02	0.01	0.02	0.07	0.03	0.04	0.01	0.01	0.01	0.37
Material follow up and Procurement	0.1	0.14	0.12	0.1	0.14	0.07	0.09	0.04	0.06	0.17	0.12	0.18	0.08	0.07	0.11	1.59
Production Operation Process	0.08	0.05	0.09	0.08	0.08	0.08	0.04	0.02	0.07	0.06	0.12	0.17	0.07	0.02	0.04	1.07
Production Programming	0.05	0.02	0.06	0.05	0.05	0.04	0.05	0.01	0.03	0.11	0.03	0.13	0.04	0.02	0.03	0.72
Quality System	0.05	0.04	0.09	0.07	0.09	0.06	0.05	0.04	0.05	0.13	0.07	0.07	0.06	0.03	0.08	0.98
Products delivery	0.04	0.03	0.04	0.08	0.11	0.06	0.07	0.03	0.04	0.09	0.03	0.13	0.04	0.07	0.05	0.91
Foreign trade and service management	0.05	0.03	0.05	0.05	0.08	0.08	0.06	0.02	0.05	0.09	0.03	0.13	0.06	0.02	0.06	0.86
Transport-Reception-Custom decision	0.06	0.08	0.06	0.12	0.14	0.09	0.09	0.03	0.08	0.07	0.05	0.16	0.15	0.09	0.06	1.33
SUM	0.98	0.87	1.31	1.16	1.66	1.04	0.99	0.62	1.11	1.57	1.07	2.13	1.29	0.81	1.24	

The sum of rows is denoted by d and sum of columns is denoted by R through equation (4, 5, and 6). Addition of d and R reveals the relative importance of each factor criterion. The subtraction of d and R divides the factors into two groups: cause group and effect group (Wei, P. L. et al. (2010). When (d - R) is positive, that particular factor belongs to the cause group and when the (d- R) is negative, that factor belongs to the effect group. Therefore, the causal diagram can be obtained by mapping the dataset of the (d + R, d - R).

$$T = \left[t_{ij}\right] n{*}n, \quad i, j = 1, 2, 3, 4, \ldots\ldots n \tag{4}$$

$$d = \sum_{j=1}^{n} t_{ij} = \left[t_i\right] n{*}1 \tag{5}$$

$$R = \sum_{i=1}^{n} t_{ij} = \left[t_i\right] 1{*}n \tag{6}$$

Where, d and R are the sum of rows and columns respectively in total relation matrix T.

Causal Diagram

The interrelationships among the flexible factors of benchmarking of ISCM performance are obtained using DEMATEL technique. Initially the direct influence matrix (D) and the total influence matrix (T) were obtained (Wu, H. H. et al. (2010). The degree of influence of the factors of interest in this study is shown in table 4.

Table 4: Degree of Influence of Factors of ISCM Benchmarking

ISCM Factors	d	R	d+R	d-R
Human Resources Orientation	1.79	0.98	2.77	0.81
Inbound logistics	1.67	0.87	2.54	0.8
Operational logistics	1.23	1.31	2.54	-0.08
Outbound logistics	0.99	1.16	2.15	-0.17
Economies of scale	1.16	1.66	2.82	-0.5
Flexibility	1.55	1.04	2.59	0.51
Logistics strategies	1.63	0.99	2.62	0.64
New Product development system	0.37	0.62	0.99	-0.25
Material follow up and Procurement	1.59	1.11	2.7	0.48
Production Operation Process	1.07	1.57	2.64	-0.5
Production Programming	0.72	1.07	1.79	-0.35
Quality System	0.98	2.13	3.11	-1.15
Products delivery	0.91	1.29	2.2	-0.38
Foreign trade and service management	0.86	0.81	1.67	0.05
Transport-reception-custom decision	1.33	1.24	2.57	0.09

Based on the above analysis; a comprehensive impact relation map has been generated, as illustrated in figure 3. The values d, R, d+R, and d- R represent the relationships among the factors. The d value reflects the influence on other factors, while the R factor reflects the influence from other factors (Wu, W. 2008), Yang, Y.P. et al. (2008). D+R represents the degree of the relationship between factors, while d-R represents the degree of the effect.

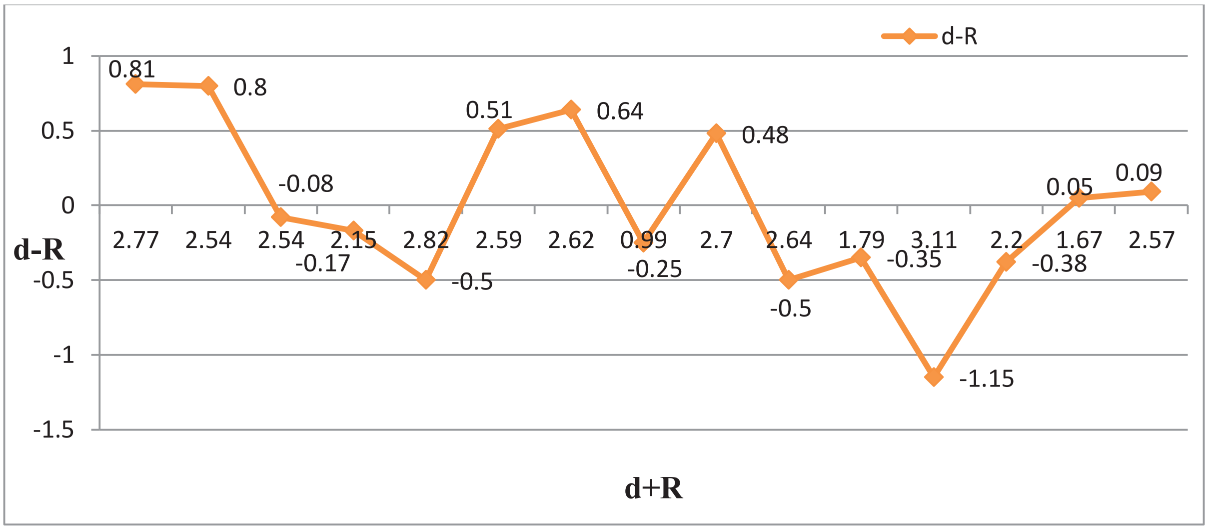

Fig. 3: Causal Diagram

In fig. 3 the factors are plotted taking abscissa as d+R, and the ordinate as d-R. From the initial DEMATEL analysis, the three factors with the highest d+R values are in decreasing mode: Quality system: 3.11, Economics of scale: 2.82 and Human resource orientation: 2.77. For a manufacturing industry, it is possible that customers from the target market have different choices of items, so it's essential to manage the demand and quick respond to customer (Wu, H. H. & Tsai, Y. N.2011). Quality system always plays a vital role in success of internal supply chain of manufacturing industry. Economics of scale in information system is required to cope up with this uncertain requirement, as it gives support to changing requirement of business function. The sum of rows d tells about the influence of particular factor over other internal supply chain benchmarking factor. It means if row sum is higher than influence will be the higher.

Result

The cause and effects diagram is shown in figure 3. It may be concluded that among these fifteen flexibility factors of benchmarking of ISCM. Quality system is the most important (highest degree of relationship) factor by the highest (D+R) priority of 3.11 as compare to other factors.

Conclusion

The proposed DEMATEL technique considered different factors associated with benchmarking of ISCM. The implementation of DEMATEL technique yielded the priorities of different factors. These factors are based on extent research review of literature. The initial direct influence matrix has been prepared on the basis of brainstorming activity with experienced managers like: Mr Sanjay Singh (Manager), Mr Kamal Kant Bhandari (General Manager), Mr. Sarabjeet Singh (G.M), Mr. Gajender Sharma (Manager), etc of Heavy Fabrication works manufacturing industries. Thereafter, authors have developed the normalized influence matrix, total influence matrix and finally a cause and effect relationship amongst the factors. The variable factors of benchmarking of ISCM do not only enable manufacturing industries to change the system as per business needs but also give them edge and act as benchmark over other competitors. From the result it is very clear that quality system is highest degree of relationship as compare to other factors. Therefore, quality system receives the maximum influence from other factors. This research study has made an attempt to analyze factors of ISCM benchmarking and prioritize them. Figure 3 show the relationship amongst these factors and the degree to which they affect to each other. The possible number of factors are classified into two group like cause group and effect group. The cause group consists of seven factors like: Human Resources Orientation, Inbound logistics, Flexibility, Logistics strategies, Material follow up and Procurement, Foreign trade and service management, and Transport-Reception-Custom decision. While effects group consists of eight factors like: Operational logistics, outbound logistics, Economies of scale, New Product development system, Production Operation Process, Production Programming, Quality System, and Products delivery. If manager's control the cause factors then the achievement of more profits can be obtained.

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