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Segmenting critical factors for enhancing the use of IT in humanitarian supply chain management

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Abstract

This study intends to explore and segment the critical factors (CFs) to enhance the use of Information Technology (IT) in Humanitarian Supply Chain (HSC), particularly in the Indian context. In this study, ten influencing factors has been identified through an extensive literature review and expert opinion. A structural model and cause – effect relationship diagram was developed using decision-making trial and evaluation laboratory (DEMATEL) method for the identification of CFs. The present study adopt a comprehensive and rigorous procedure to identify six CFs namely, top management support, Government support, feedback mechanism to facilitate learning from prior experiences, transparent and accountable supply chain, strategic planning, and mutual learning with other commercial organizations (COs). The developed framework provides a simple, effective and efficient way to enhance the utilization of IT in HSC and in large to improve the competencies and performance of HSC.

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Keywords: Humanitarian Supply Chain Management; DEMATEL; Critical Factors; Information Technology

1. Introduction

Thomas & Mizushima (2005) defined Humanitarian Supply Chain Management (HSCM) as “The process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well

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as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people." Under the pressure to proactively deal with the situation arising due to disasters, many researchers have highlighted the use and benefits of IT in HSCM (Gustavsson, 2003; Tomasini & Van Wassenhove, 2009). Beynon-Davis (2009) defines "IT as any technology used to support information gathering, processing, distribution, and use and is composed of hardware, software, data, and communication technology."

The utilization of IT enhances information sharing, coordination, and collaboration among the actors in HSCM (Cate, 1994; Patterson, 2005; Pettit & Beresford, 2009; Roh, Pettit, & Beresford, 2008; Tomasini & Van Wassenhove, 2009; Troy, Carson, Vanderbeek, & Hutton, 2007; Whybark, 2007). Despite the importance and promising benefits of IT, there is not efficient utilization of IT in HSCM. The issues on which the paper focuses has been overlooked by many researchers (Kovács & Tatham, 2009). Therefore, need arises to identify various influencing and CFs to enhance the utilization of IT in HSCM. In contrast, past studies usually examine CFs for the whole system, relatively few studies exist on the CFs related to enhance the utilization of IT in HSCM.

Moreover, there are several factors that need to be considered to enhance the utilization of IT, and it is not possible to improve all the factors at the same time. In view this limitation, this study proposes a framework to explore CFs by segmenting various different factors into groups to improve them in a stepwise way. DEMATEL is used to identify various influencing factors and CFs uses a structural model, i.e. cause-effect relationship diagram. Although other Multi Criteria Decision Making (MCDM) techniques such as Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) can also solve the purpose, DEMATEL considers all the factors as interdependent on each other while other MCDM considered the factors as independent.

Extensive Literature review and the discussions with experts have been conducted to identify various influencing factors. After finalizing the list of influencing factors, experts were asked to rate the influencing factors on the basis of scale to form a structural model (cause and effect relationship) for the identification of CFs. This paper intends to explore the various influencing factors in enhancing the use of IT in the HSCM and; to investigate the CFs out of these influencing factors on the basis of and cause and effect relationship diagram.

The rest of the paper is organized as follows: Section 2 explains previous studies in the area of IT in relief operations, Section 3 presents the methodology adopted for this study, Section 4 explains the CFs for the study followed by the discussion in the Section 5, and finally, conclusion, limitation and scope for paper related future work is presented in the Section 6.

2. Literature review

Rubin and Seeling in 1967 was the pioneer in success and failure factors. The term critical success factors (CSFs) also known as "key success factors" was coined by Rockart (1979) and Sloan School of management. CSFs are "those things that must be done if a company is to be successful" (Freund, 1988) and those factors which requires the immediate attention of higher authorities in an organization. The concept of CFs has been widely studied in the commercial context but rarely applied in the humanitarian sector (Zhou, Huang, & Zhang, 2011).

Strategic tie up among actors involved in relief operations can positively influence the performance and knowledge sharing capabilities of the organizations (McEntire, 2002). Top Management commitment or positive leadership is vital in overcoming the problem of funds, strategic planning, awareness, trust and other issues (Moshtari & Gonçalves, 2011; Ponomarov & Holcomb, 2009; Thévenaz & Resodihardjo, 2010; Waugh & Streib, 2006).

Countries all over the world have been developing the strategies to enhance the preparedness measure for the HSCM (ICHL, 2013). The key problem emphasized by practitioners in enhancing the technical capabilities of the humanitarian sector is the behaviour of donors (Gustavsson, 2003). Donors do not prefers to donate as the HSCM lacks the accountability and transparency mechanism (Agostinho, 2013; Balcik, Beamon, Krejci, Muramatsu, & Ramirez, 2010; Thomas & Kopczak, 2005). However, the contemporary literature lacks research that explores and deals with CFs in enhancing the use of IT in HSC. Thus, after summarizing the contemporary research, this study extrapolates elements and factors influencing the use of IT (refer Table 1), and introduces DEMATEL method. In doing so, we consider the complex relationships among the factors and develop strategy map and cause-effect relationship diagram to investigate the CFs.

Table 1: List of influencing factors affecting the adoption/implementation of IT

S. No	Factor	Reference
1.	Top management support	(Kabra & Ramesh, 2013; Moshtari & Gonçalves, 2011)
2.	Mutual learning with other commercial organizations (COs)	(Agostinho, 2013; McEntire, 2002).
3.	Strategic planning	(Agostinho, 2013; Kovács & Spens, 2007; Maiers, Reynolds, & Haselkorn, 2005; Moshtari & Gonçalves, 2011; Natarajarathinam, Capar, & Narayanan, 2009; Pettit & Beresford, 2009; Schulz & Blecken, 2010)
4.	Investment in IT	(Gustavsson, 2003; Kabra & Ramesh, 2015a; Maiers et al., 2005)
5.	Efficient retention policy for knowledge workers	(Gustavsson, 2003; Maiers et al., 2005)
6.	Hiring of knowledge workers	(Gustavsson, 2003; Maiers et al., 2005)
7.	Accountable and transparent supply chain	(Agostinho, 2013; Balcik, Beamon, Krejci, Muramatsu, & Ramirez, 2010; Thomas & Kopczak, 2005)
8.	Efficient training and development for workers	(Agostinho, 2013; Drabek, 1985; Fritz Institute, 2005; Kabra & Ramesh, 2015c; Maiers et al., 2005; McEntire, 2002; Thévenaz & Resodihardjo, 2010)
9	Feedback mechanism to facilitate learning from prior experience	(Balcik et al., 2010; Ponomarov & Holcomb, 2009)
10	Government support	ICHL (2013), (Kabra & Ramesh, 2015b)

3. Research methodology

In this study, DEMATEL is used to identify the CFs in enhancing the use of IT in HSC. Expert opinion is the main input for the development of cause effect relationship model using scale 0 (no influence), 1 (very low influence), 2 (low influence), 3 (high influence), and 4 (very high influence). For the study purpose, data has been collected from the actors involved in HSCM. The overall approach for the study is based on insights gained and facts transcribed during the brainstorming sessions with the experts. The present research ensures construct validity based on a thorough review of published literature in the area of HSCM.

All the chosen experts had more than 15 years of experience in their respective domain and various literature, published reports and information were circulated among the experts beforehand. In this way, the interviewees could give their own opinions and insights on the predetermined issues of adoption of IT in HSCM. Further, the information recorded during the interview was sent to the respective interviewees to ensure the reliability of information.

3.1 DEMATEL

DEMATEL method was developed in Geneva Research Centre in 1973; which is based on graph theory, and best suited for multi criteria decision making (MCDM) problems using visualization method. First, the structural model (cause and effect relationship diagram) is developed, to present and analyse the interdependence relationship among various influencing factors. Second, using the structural model, all factors are segmented into two groups i.e. causal and effect factors and finally CFs are identified. DEMATEL converts the cause and effect factors into a structural model, as proposed by Shieh, Wu, & Huang (2010), Wu & Tsai (2011), Wu (2012), Wu & Lee (2007) by following steps:

Step 1: Creating the direct relation matrix: Measuring the relationship between criteria using the comparison scale designed into four levels: 0 (no influence), 1 (very low influence), 2 (low influence), 3 (high influence), and 4 (very high influence). An initial direct relation matrix A is a n x n matrix obtained by pair-wise comparisons, in which aij is denoted as the degree to which the criterion i affects the criterion j, and diagonal values aij when i=j is 0.

Step 2: Normalizing the direct relation matrix: Normalization is performed using the following equation

$$K = 1/ \max_{1\leq i\leq n} \sum_{1}^{n} aij \qquad i, j = 1, 2, 3\ldots, n \tag{1}$$

$$S= K*A \tag{2}$$

Step 3: Attaining a total relation matrix: Once the normalized direct relation matrix S is obtained, the total relation matrix M is denoted as the identity matrix.

$$M = S * (I-S)^{-1} \tag{3}$$

Step 4: Producing a causal diagram: The sum of rows and the sum of columns are separately denotes as vectors D and R within the total relation matrix M. A causal and effect graph can be acquired by mapping the dataset of (X + Y, X - Y). The horizontal axis vector (X + Y) named "Prominence" is made by adding X to Y, which reveals how much importance the criterion has. Similarly, the vertical axis (X - Y) named "Relation" is made by subtracting Y from X, which may group criteria into a cause group. Or, if the (X - Y) is negative, the criterion is grouped into the effect group.

$$M = [m_{ij}]_{nxn}, \qquad i, j = 1, 2, 3\ldots, n \tag{4}$$

$$X = [\sum_{i=1}^{n} tij]_{1xn} = [m_j]_{nx1} \tag{5}$$

$$Y = [\sum_{j=1}^{n} tij]_{1xn} = [m_j]_{nx1} \tag{6}$$

Step 5: Obtaining the inner dependence matrix: In this step, the sum of each column in total relation matrix is equal to 1 by the normalization method, and then the inner dependence matrix can be acquired.

4 Applications of proposed method

Step1: Form expert panel: The expert panel consists of 5 members including 2 IT professionals, 2 academicians and 1 expert from commercial organizations (COs).

Step 2: Calculate the normalized initial direct relation matrix S: The generalized direct relation matrix S is calculated using equation 1.

Step 3: Derive the total-relation matrix T: The total-relation matrix M is calculated using equation 2 from the generalized direct-relation matrix S.

Step 4: Obtain the sum of rows and columns of matrix T: The sum of rows and the sum of columns are denoted as X and Y respectively, within the total relation matrix M

Step 5: Set up degrees of central role and relation: Degree of the influence for each factor is calculated using equation 4 and 5.

Step 6: build a cause and effect relationship diagram: This study integrates the responses of all experts to find out the important evaluation factor and built a structural model.

4.1 Identification of CFs

CSFs were identified using Figure 1.

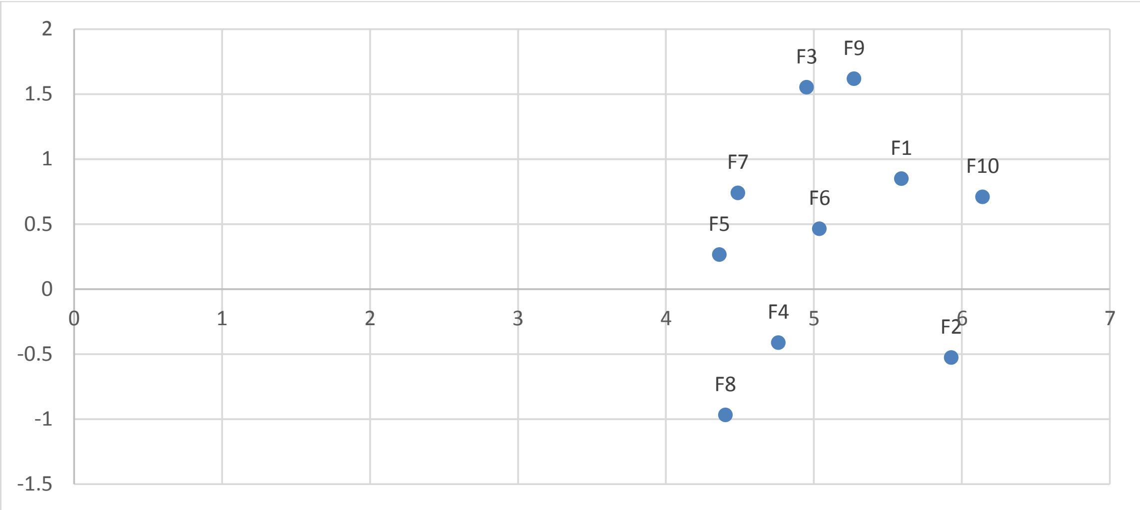

Figure 1: Cause and effect structural model

4.1.1 Cause factors analysis

The performance of the cause factors can greatly influence the overall goal due to its net impact on the whole system. Hence, it is generally accepted that factors in cause group should be paid more attention. The ‘‘Top management support” (F1) has the highest X+Y, among the factors in cause group, which means that F1 dispatches more impact on the whole system than that it receives from other factors. It is indicated that F1 has remarkable impact on other factors. Hence, F1 is a CF that worth much more attention to enhance the utilization of IT in HSCM. Similarly, ‘‘Government support” (F10), ‘‘Feedback mechanism to facilitate learning from prior experience” (F9), ‘‘Strategic planning” (F7), ‘‘Accountable and transparent supply chain” (F11), are also recognized as a CF.

The ‘‘Efficient Retention Policy for Knowledge workers” (F5) have the lowest D+R as compared to other factors in the system and also degree of influential impact is low as well as X-Y. As a result; F9 is not recognized as a CF. Similarly “Hiring of Knowledge workers” (F6) is also not recognized as a CF.

4.1.2 Effect factors analysis

The effect group factors are unsuitable to be a CFs because of its tendency to be easily impacted by others. Still it is essential to discuss effect factors to find out the feature of each factor. The “Mutual Learning with other commercial organizations (COs)” (F2), has high D+ R value showing that it is one of the most important factor for the whole system, but it has a value less than zero for X-Y indicating that it is easily affected by other factors, but the value for D high as compared to other factors. This suggest that although F2 is a net receiver but it has a significant impact on the whole system. Hence, F2 is a CF.

The “Efficient training and development for workers” (F8) has the highest degree of influences from other factors and low degree of influential. Hence F8 is not a CF. Similarly, “Investment in IT” (F4), is also not a CF. They depends on other factors such as top management support, Government Support, feedback mechanism to facilitate learning from prior experience and accountable and transparent supply chain.

5. Discussion

This study is an attempt to enhance the utilization of IT in HSCM, so that the solutions can be implemented in a stepwise manner. This study uses the DEMATEL framework to identify the CSFs. According to the results of this study, six CFs were identified namely, ‘‘Top management support” (F1), ‘‘Government support” (F10), ‘‘Feedback mechanism to facilitate learning from prior experience” (F9), ‘‘Strategic planning” (F3), ‘‘Accountable and transparent supply chain” (F7) and one effect factor namely, “Mutual Learning with other commercial organizations (COs)” (F3).

Specifically, Government Support is the most important factor that influences the utilization of IT in HSCM. The government plays the role of the central authority in relief operations. The government of the country should facilitate all the required resources to enhance the use of IT, like providing enough funds, training to field workers, providing a necessary infrastructure, coordination, to name a few. Another important identified CFs is top management support (F1), which is very crucial as it is required to ensure continued success of the program and processes put in place.

HSC has a large number of stakeholders, from both the government and the private sector (Balcik et al., 2010; Dolinskaya, Shi, & Smilowitz, 2011; Kovács & Spens, 2007). Stakeholders should coordinate with each other, as their collaboration can triggered the process of utilization of IT by developing effective and efficient strategies (Maiers et al., 2005; McEntire, 2002). In particular, for enhancing the use of IT, need arises to streamline the activities of actors in commercial supply chain (CSC) and HSC as the COs has all the expertise who can manage the IT function of the organizations at different levels i.e. strategic, tactical and the operational levels (Agostinho, 2013). Strategic planning is also needed in streamlining the activities of COs and actors of HSC, to ensure long term commitment of the private sector, since every corporate house is actively involved in social responsibility programmes and it is easier to redefine these programmes along with humanitarian activities.

Implementation of IT in the HSC is an involved and complicated endeavour and requires strategic planning and this will required the support from all end of the sector. Strategic planning is also needed in streamlining the activities of COs and actors of HSC, to ensure long term commitment of the private sector, since every corporate house is actively involved in social responsibility programmes and it is easier to redefine these programmes along with humanitarian activities.

It is required to view the disaster management process holistically instead of short term oriented. Mutual Learning between commercial organizations and humanitarian relief organizations is needed to enhance the knowledge level of the HROs management and employees and to create knowledge sharing culture in the HROs, since HROs are already 10 -15 years behind the COs in terms of technology and knowledge level (Gustavvson, 2003; Van Wassenhove 2006).

6. Conclusion

In recent years, the use of IT is a successful strategy to improve the performance of humanitarian supply chain. Due to the necessity of enhancing the use of IT in HSC, this study explores the factors influencing the use of IT and constructs structural model using DEMATEL. This study explores the CFs to enhance the use of IT in HSC within Indian context. This study proposes a more robust and comprehensive framework to understand the interrelationships among the criteria’s in a systematic manner. The results of this study can hopefully help the actors in HSC to successfully implement IT in their operations.

This study identifies six CFs to enhance the use of IT such as top management support, Government support, feedback mechanism to facilitate learning from prior experiences, transparent and accountable supply chain, strategic planning and mutual learning with other commercial organizations (COs). The result indicates that top management support and Government support has the most influencing and the strongest connection to other criteria. The findings of this study not only offers a meaningful base to deepen the understanding, but also provides a clue to develop an effective way to enhance use of IT in a stepwise manner. Despite these contributions the present study is not free from limitations. In this study, the focus was on the higher level factors based on the expert’s opinion and literature. This study could be extended on the sub factors of the higher level factors to analyse more specific issues for enhancing the use of IT and could be considered as the scope for future research.

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