

## DETERMINATION OF EFFECTIVE CRITICAL SUCCESS FACTORS IN SUCCESSFUL IMPLEMENTATION OF ERP BY USING FUZZY DEMATEL METHOD

### ERP’NİN BAŞARI İLE UYARLANMASINA ETKİ EDEN KRİTİK FAKTÖRLERİNİN FUZZY DEMATEL YÖNTEMİ İLE BELİRLENMESİ

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#### ABSTRACT

*Successful Enterprise Resource Planning (ERP) implementation is very important issue in today’s globalised world trade and depends on paying high attention on critical success factors (CSFs) affecting ERP implementation. In our study, we analyzed 8 CSFs by using fuzzy DEMATEL methodology which serves a highly effective structural decision making system for modeling cause and effect relationships. Among 8 CSFs, top management support and project team leader who commit himself/herself to ERP implementation success are found to be the most important factors that influenced other factors. This study is the first reference in the literature which uses a fuzzy DEMATEL technique in determination of effective CSFs in implementation of successful ERP.*

**Key Words:** Critical Success Factors, ERP Implementation, Fuzzy DEMATEL.

**Jel Codes:** C44.

#### ÖZET

*Günümüz globalleşen dünya ekonomisinde işletmelerin başarılı bir şekilde Kurumsal Kaynak Planlama (ERP) sistemlerini kurması ve bunun başarılmasına etki eden kritik faktörlerin belirlenmesi önemli bir konu haline gelmiştir. Bu çalışmada, sebep sonuç ilişkileri modellemede güçlü bir karar destek yöntemi olan fuzzy DEMATEL ile 8 kritik başarı faktörü analiz edilmiştir. ERP uyarlanmasına etki eden 8 kritik başarı faktörü içerisinde tepe yönetim desteği ve kendisini ERP başarısına adanmış proje yöneticisi diğerlerine etki eden en önemli faktörler olarak tespit edilmiştir. Bu çalışma ERP nin başarılı uyarlanmasına etki eden faktörleri fuzzy DEMATEL kullanarak analiz eden ilk referans çalışmalardandır.*

**Anahtar Kelimeler:** Kritik Başarı Faktörleri, ERP Uyarlama, Fuzzy DEMATEL.

**Jel Kodları:** C44.

## 1. INTRODUCTION

In today’s global market, bitter competition enforces companies to make use of available tools in order to achieve responsive and accurate decision making process across the entire organizations. From top management to the first line supervisors, decisions ought to be taken in harmony and be as responsive and accurate as possible. Frameworks such as Material Requirements Planning (MRP I), Manufacturing Resource Planning (MRP II) and Enterprise Resource Planning have given rise over past 50 years respectively to tackle various issues around decisiveness (Basoglu, 2007).

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The Enterprise Resource Planning (ERP) is the most mature and comprehensive framework widely adopted as a useful tool to thoroughly integrate managerial and administrative functions, which involves the product life cycle in every governmental and non-governmental the companies and organizations. ERP is implemented with fully integrated computer software solutions, which enables with effective and efficient information flow and successful resource management throughout the organization (Davenport, 1998). It also complies with the requirements of departments and functional areas by combining them into unique computer set up (Genoulaz, 2005). The main motivation behind adopting and implementing ERP systems is to benefit of the following targets:(i) effective information costs, (ii) better customer relationships with retrieving the most up-to-date information, (iii) rapid response time to the changes, (vi) adopting emerging technologies to improve competitiveness, (v) making decision as fast and accurate as possible, (vi) decreasing operation costs including better intra and interdepartmental relationships, (vii) preventing disagreement between departments and managers, monitoring and controlling operations,etc. (Markus and Tanis, 2000, Gibson et al., 1999, Umble et al., 2003, Watson and Schneider, 1998, Kumar et al., 2003, Lonziński, 1998).In fact, due to various reasons, it is observed that companies fail to achieve abovementioned targets in most of the time (Kumar et al., 2002, Langenwaller, 2000, Law and Ngai, 2007, Li et al., 2001, Mabert et al., 2003, Motwani et al. 2005, Schniederjans and Kim, 2003, Scott and Vessey, 2000).

Although ERP provides competitive advantage to the organizations, implementation problems have been recorded which lead to failure of ERP (Kumar et al., 2002,2003, Langenwaller, 2000, Law and Ngai, 2007, Li et al., 2001, Mabert et al., 2003, Markus et al., 2000, Marsh, 2000, Motwani et al. 2005, Nah et al., 2001,2003, Nandhakumar et al., 2005, Reimers, 2002, 2003, Robey et al., 2002, Sarker and Lee, 2003, Schniederjans and Kim, 2003, Scott and Vessey, 2004, Sheu et al., 2004, Skok and Ledge, 2002). Holland and Light discuss that approximately 90% of ERP implementations are either late or over budget, which may be due to poor costing and scheduling or un-foreseen changes in project scope rather than failure in project management (Holland and Light, 1999). In order to achieve a successful implementation of ERP, considerable amount of studies have been focused on how to determine the critical success factors for the implementation phase of the ERP in the literature (Holland and Light, 1999, Bingi et al., 1999, Motwani et al., 2002, Umble and Umble, 2002, Hong and Kim, 2002, Ngai et al., 2008, Bradley, 2008, Sun et al., 2005). At this point, the imperative issue is how to increase the number of successful ERP implementations by segmenting a set of critical success factors.However, few studies discuss this issue.

Decision Making Trial and Evaluation Laboratory (DEMATEL) is the most appropriate technique to find appropriate solution for this problem.The DEMATEL method was initiated by Gabus and Fontela (1972, 1973), which works as a structural model of gathering group information and visualizing the causal relationships of criteria by using graphical diagrams.It uses an ordinary information processing procedure.

It is often observed that using ordinary (crisp) values in decision making has substantial drawbacks when decisions are taken in vague environment. In fact, human decisions about preferences usually include uncertainty and it is difficult to explain this uncertainty by crisp values. Fuzzy logic is the most useful tool used to handle uncertainty and vagueness of decision making process (Zadeh, 1965, Bellman and Zadeh, 1970).

In order to benefit of using non-crisp values in decision making process of DEMATEL method, it has been combined with Fuzzy logic for more realistic decisions. There are

several studies which combine DEMATEL and Fuzzy logic in the literature (Wu and Lee, 2007, Tsai and Chou, 2009).

The following sections of the paper are organized as follows. Literature Review on ERP implementation success factors and applications of DEMATEL-fuzzy logic combination is presented in section 2. In section 3, proposed method is described. In section 4, empirical study is presented. Section 5 is dedicated to discussion about results of the study. Conclusion and further study opportunities are presented in the last section.

## 2. LITERATURE REVIEW

In literature review, it was observed that considerable amount of studies has been done on critical success factors for the successful implementation of ERP. Ngai et al. (2008) reviewed literature in 10 different countries to identify the critical success factors of the implementation of ERP. They defined 18 critical success factors with 80 sub factors for the successful implementation of ERP. Bradley (2008) examined 10 critical success factors in relation to project success and analyzed 8 implementation projects qualitatively. At the end, it is found that 3 critical success factors (choosing the right full time Project manager, personnel training and presence of champion) are important for successful implementation of ERP. Sun et al. (2005) assessed the critical success factors for the small manufacturing enterprise for the achievement of ERP implementation. Malhotra and Temponi (2010) made research on small businesses and determined 6 critical decisions which are very important for successful implementation: (1) project team structure, (2) implementation strategy, (3) database conversion strategy, (4) transition technique, (5) risk management strategy and (6) change management strategy.

Basoglu et al. (2007) surveys several organizations which have implemented ERP systems to determine critical issues in ERP adoption. They argue that ERP system success can be classified in to 6 categories: system quality, information quality, usage of the system, user satisfaction, individual impact and organizational impact.

Al-Mashari et al. (2003) determine the critical success factors (CSF) for the successful implementation of ERP systems as (1) Top management support, (2) users' training, (3) Project communication, (4) Project management, (5) system integration, (6) cultural differences, (7) ERP package selection, legacy systems, (8) process engineering activities and customization of ERP. Gyampah and Salam (2004) also determine the CSFs as (1) Top management support, (2) users' training, (3) communication within the project team and (4) users' acceptance. There are several other studies identifying these CSFs in the literature (Umble et al., 2003, Bingi et al., 1999, Ngai et al. 2008, Bradford and Florin, 2003, Somers and Nelson, 2003, 2004, Yusuf et al., 2004, Gyampah, 1999, Aladwani, 2007).

Grabski and Stewart (2007) conducted surveys on chief information officers and internal audits of firms and concluded that control procedures are necessary to employ for successful implementation of ERP. Chien et al. (2007) surveyed 244 small and medium sized firms which implemented ERP in China and Taiwan. They concluded that both centrifugal forces (Free flow of information in project team, Connectedness with user department, Unfocused information-seeking) and Centripetal forces (Existence of superordinate goal, Temporal pacing, Centralization of decision making) plays a critical roles in successful implementation of ERP. They also discussed that these forces, themselves, do not influence ERP project success, but, do so in certain combinations.

Wang et al. (2008) surveyed 90 Taiwanese manufacturing firms and concluded that consistency among critical factors facilitates the implementation of ERP. Facilitating factors investigated in this study are (1) vendor support, (2) consultant competence, (3) competence of ERP project team member, (4) ERP Project manager leadership, (5) top management support, and (6) user support.

After Gabus and Fontela (1972, 1973) initiated Decision Making Trial and Evaluation Laboratory (DEMATEL) technique, lots of studies have been concentrated on structural model that gathers group knowledge and visualize the causal relationship of criteria by using graphical diagram since then (Wu and Lee, 2007, Tsai and Chou, 2009, Tzeng et al., 2007).

Wu and Lee (2007) proposed a method for competency development of global managers by using DEMATEL in combination with fuzzy logic. Zhou et al. (2011) used fuzzy DEMATEL method in order to determine influencing critical success factors of emergency management. They defined 5 critical success factors as influencing factors in emergency management. Chang et al. (2011) studied fuzzy DEMATEL method in determining key factors in suppliers election for supply chain management. Their model evaluates supplier performance to find influencing critical success factors in supplier selection.

**3. FUZZY DEMATEL METHOD**

Gabus and Fontela (1972, 1973) introduced Decision Making Trial and Evaluation Laboratory (DEMATEL) method in 1973. DEMATEL serves a structural model that gathers group knowledge and visualize the causal relationship of criteria by using graphical diagram. Graphical diagram and matrices being produced in this technique represents relation between criteria as well as the strength of relationship. Since the nature of human judgment is vague and unclear, defining preferences by crisp values is usually inadequate in real world. Therefore fuzzy logic has to be applied in these situations. Fuzzy DEMATEL technique take uncertainty and vagueness in to consideration while determining the causal relationship between criteria.

Fuzzy DEMATEL technique consists of 7 basic steps;

**Step 1:** Objectives to be achieved and Evaluation criteria with respect to objectives are determined.

**Step 2:** Decision makers are asked to indicate their opinions about the relationship between criteria. Since human judgment on evaluation criteria include uncertainty, five linguistic terms “Very high influence, High influence, Low influence, Very low influence, No influence” are determined. Then these linguistic terms are expressed as positive triangular fuzzy numbers as shown in Table 1. The answers of decision makers in terms of linguistic terms are converted to triangular fuzzy numbers.

**Step 3:** Let  $\tilde{z}^i$  is the i’th the valutors fuzzy decision matrix about the criteria expressed in terms of fuzzy triangular numbers.  $\tilde{z}^i$  is normalized as follows

$$\tilde{X}^i = \begin{bmatrix} \tilde{x}_{1,1}^i & \tilde{x}_{1,2}^i \tilde{x}_{1,3}^i & \cdots & \tilde{x}_{1,n}^i \\ \tilde{x}_{2,1}^i & \tilde{x}_{2,2}^i \tilde{x}_{2,3}^i & & \tilde{x}_{2,n}^i \\ \vdots & \ddots & & \vdots \\ \tilde{x}_{n,1}^i & \tilde{x}_{n,2}^i \tilde{x}_{n,3}^i & \cdots & \tilde{x}_{n,n}^i \end{bmatrix} \quad \text{Equation (1)}$$

$$\tilde{x}_{i,j}^t = \frac{\tilde{z}_{i,j}^t}{r} = \left( \frac{l_{i,j}^t}{r}, \frac{m_{i,j}^t}{r}, \frac{u_{i,j}^t}{r} \right) \quad \text{Equation (2)}$$

$$r = \frac{\text{Max}}{1 \leq i \leq n} (\sum_{j=1}^n u_{i,j}^t) \quad \text{Equation (3)}$$

**Step 4:** In this step, average value of nevaluators' normalized fuzzy decision matrix is found.

$$\tilde{X} = (\tilde{x}^1 + \tilde{x}^2 + \dots + \tilde{x}^n)/n \quad \text{Equation (4)}$$

**Step 5:** After finding initial direct relation matrix and normalizing it, Total relation fuzzy matrix ( $\tilde{T}$ ) is defined as follows;

$$\tilde{T} = \tilde{X} \cdot (I - \tilde{X})^{-1} \quad \text{Equation (5)}$$

**Step 6:** In this step  $\tilde{D}_i$  and  $\tilde{R}_i$  are calculated.  $\tilde{D}_i$  is the sum of the row and  $\tilde{R}_i$  is the sum of the column of  $\tilde{T}$ . Then  $\tilde{D}_i$  and  $\tilde{R}_i$  are defuzzified separately.

Defuzzification formula is as follows;

$$\text{BNP}_{i,j} = (L_{i,j} + ((U_{i,j} - L_{i,j}) + (M_{i,j} - L_{i,j}))) / 3 \quad \text{Equation (6)}$$

$\text{BNP}_{i,j}$  represents the defuzzified value of  $\tilde{D}_i$  and  $\tilde{R}_i$ . We call defuzzified value of  $\tilde{D}_i$  and  $\tilde{R}_i$  as  $D_i$  and  $R_i$  respectively.

In order to determine causal relationships between Critical success factors,  $D_i + R_i$  and  $D_i - R_i$  are calculated. While  $D_i + R_i$  represents degree of central role (how much importance the criteria has),  $D_i - R_i$  shows the degree of relation. Relation divides the criteria in to cause and effect group. If  $D_i - R_i$  is positive then criteria belong to cause group. If  $D_i - R_i$  is negative then criteria belong to the effect group.

**Step 7:** Causal diagram is constructed. In this diagram the horizontal axis represents  $D_i - R_i$  while vertical axis represents  $D_i + R_i$ . In this diagram, Criteria above the horizontal axis mean that they belong to cause group. Criteria below the horizontal axis mean that they belong to effect group.

#### 4. EMPIRICAL STUDY

In this empirical study, the critical success factors that affect the successful implementation of ERP were examined. A set of 8 factors (evaluation criteria) were identified as critical considering our objective of success for ERP implementation, These are (1) Top management support, (2) Building a project team and effective project management, (3) Service quality of internal and external technical support and consultancy, (4) Meeting the corporation requirements with minimum revision, (5) Having exact and full information, (6) Clear determination of goal and objectives, (7) Management of change in working methods in corporation, (8) Project team leader who committed himself/herself to ERP implementation success. Then, a questionnaire was designed for collecting opinions of experts who took active roles on implementation of ERP projects. Experts were chosen from different sectors and from different ERP software implementations (domestic and foreign). Sectors chosen for this study are iron & steel industry, railway carriage production sector, aluminum joinery sector, integrated meat plants, textile sector. ERP software from a wide variety of vendors and various implementation cross-industries have also been chose. Under these circumstances, 15 experts were asked to make pair wise relationships between

each pair of 8 critical success factors. Experts identified their opinions through linguistic scale determined in Table 1. As an example, the assessment data of one expert is shown in table 2. C1 through C8 are critical success factors in Table 2.

Assessment data of each expert in linguistic scale were then converted to triangular fuzzy numbers by using conversion rules. As an example, assessment data of an expert is redefined as triangular fuzzy numbers in Table 3. C1 through C8 are critical success factors and L, M, U are the lower, medium and upper limit of triangular fuzzy numbers respectively.

Totally 15 assessment matrices were obtained from experts. Each matrix (also called as initial direct relation matrix) was then normalized by using Eq. (2) and Eq. (3). Then, the normalized direct relation matrix was obtained with averaging of 15 normalized direct relation matrices by using Eq. (4). Normalized direct relation matrix is shown in Table 4.

Next, Total relation matrix (Table 5) was obtained by using Eq. (5).

Next,  $\tilde{D}_i$  and  $\tilde{R}_i$  were calculated.  $\tilde{D}_i$  is the sum of the row and  $\tilde{R}_i$  is the sum of the column of  $\tilde{T}$ . Then  $\tilde{D}_i$  and  $\tilde{R}_i$  were defuzzified separately by using Eq. (6). Then,  $D_i+R_i$  and  $D_i-R_i$  were calculated. The values of  $\tilde{D}_i$ ,  $\tilde{R}_i$ ,  $D_i$ ,  $R_i$ ,  $D_i+R_i$  and  $D_i-R_i$  are shown in Table 6.

After that, the causal diagram (Figure) was constructed by mapping a dataset of (D+R, D-R).

The causal diagram easily suggests that only 2 critical success factors out of 8 are the effected ones. These factors are C1 (Top management support) and C8 (Project team leader who committed himself/herself to ERP implementation success). The rest of the factors are positioned as effecting ones.

## 5. DISCUSSIONS

In this empirical study, a case of successfully implementing ERP software to the corporations is examined through 8 critical success factors. Results suggest that several implications about implementation of ERP can be derived as follows;

Causal diagram provides valuable information on effective critical success factors in implementation of ERP. If higher efficiency in effect group of critical success factors is required, the attention must be paid to cause group of critical success factors. Among 8 critical success factors, Top management support (C1) and project team leader who commit himself/herself to ERP implementation success (C8) are found to be the most important factors that influenced other 6 factors in effect group.

The relationships indicated on cause and effect diagram clearly shows that top management support and commitment to implementation of ERP leads to effective project management, having exact and full information and clear determination of goal and objectives. Whereas effective project team leader brings corporation the acquisition of higher service quality of internal and external technical consultancy, effective management of changing working conditions due to ERP implementation, effective project management and meeting company requirements with minimum revision.

## 6. CONCLUSIONS

Successful Enterprise Resource Planning (ERP) implementation is very important issue in today's global market and depends on paying high attention on critical success factors (CSFs) affecting ERP implementation. In our study, we analyzed 8 CSFs by using fuzzy DEMATEL methodology which works as a highly effective structural decision making

system for modeling cause and effect relationships. Among 8 CSFs, top management support and project team leader who commit himself/herself to ERP implementation success are found to be the most important factors that influenced of other factors. This study is the first reference in the literature which uses a fuzzy DEMATEL technique in determination of effective CSFs in implementation of successful ERP. As an extension of our work, It is possible to construct other structural frameworks with expanded critical success factors to see the cause and effect relationships and compare them with results of this study.

**7. TABLES AND FIGURES**

Table 1: Fuzzy Linguistic Scale

Linguistic term	Triangular fuzzy number
No Influence	(0, 0, 0.25)
Very Low Influence	(0, 0.25, 0.50)
Low Influence	(0.25, 0.50, 0.75)
High Influence	(0.5, 0.75, 1.0)
Very High Influence	(0.75, 1.0, 1.0)

Table 2: Assessment data of an expert in linguistic scale

	C1	C2	C3	C4	C5	C6	C7	C8
C1	-	L	VH	No	VL	VH	VH	VH
C2	L	-	VH	No	VH	VH	H	L
C3	VH	H	-	VH	VH	VH	VH	L
C4	L	L	VH	-	VH	L	L	L
C5	VL	No	VH	VL	-	L	No	VL
C6	VH	VH	VH	No	VH	-	H	VH
C7	VH	VL	VH	VH	VL	L	-	H
C8	VH	VH	VH	L	VH	VH	VH	-

Table 3: Assessment data of an expert in triangular fuzzy numbers

	C1			C2			C3			C4			C5			C6			C7			C8		
	R	L	U	R	L	U	R	L	U	R	L	U	R	L	U	R	L	U	R	L	U	R	L	U
C1	0	0	0	0.25	0.5	0.75	0.75	1	1	0	0	0.25	0	0.25	0.5	0.75	1	1	0.75	1	1	0.75	1	1
C2	0.25	0.5	0.75	0	0	0	0.75	1	1	0	0	0.25	0.75	1	1	0.75	1	1	0.5	0.75	1	0.25	0.5	0.75
C3	0.75	1	1	0.5	0.75	1	0	0	0	0.75	1	1	0.75	1	1	0.75	1	1	0.75	1	1	0.25	0.5	0.75
C4	0.25	0.5	0.75	0.25	0.5	0.75	0.75	1	1	0	0	0	0.75	1	1	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
C5	0	0.25	0.5	0	0	0.25	0.75	1	1	0	0.25	0.5	0	0	0	0.25	0.5	0.75	0	0	0.25	0	0.25	0.5
C6	0.75	1	1	0.75	1	1	0.75	1	1	0	0	0.25	0.75	1	1	0	0	0	0.5	0.75	1	0.75	1	1
C7	0.75	1	1	0	0.25	0.5	0.75	1	1	0.75	1	1	0	0.25	0.5	0.25	0.5	0.75	0	0	0	0.5	0.75	1
C8	0.75	1	1	0.75	1	1	0.75	1	1	0.25	0.5	0.75	0.75	1	1	0.75	1	1	0.75	1	1	0	0	0

Table 4: The Normalized direct-relation matrix

	C1			C2			C3			C4			C5			C6			C7			C8		
	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U
C1	0.0000	0.0000	0.0000	0.0760	0.1141	0.1398	0.0751	0.1131	0.1388	0.0247	0.0370	0.0751	0.0123	0.0370	0.0751	0.0884	0.1284	0.1521	0.1007	0.1388	0.1521	0.1017	0.1398	0.1521
C2	0.0123	0.0370	0.0751	0.0000	0.0000	0.0000	0.0874	0.1254	0.1388	0.0370	0.0627	0.0884	0.0741	0.0988	0.1121	0.0741	0.1121	0.1254	0.0494	0.0741	0.1121	0.0504	0.0884	0.1284
C3	0.0494	0.0874	0.1131	0.0494	0.0741	0.1121	0.0000	0.0000	0.0000	0.0884	0.1254	0.1521	0.0874	0.1254	0.1388	0.0751	0.1131	0.1388	0.0751	0.1131	0.1388	0.0514	0.0884	0.1274
C4	0.0123	0.0504	0.0884	0.0247	0.0494	0.0874	0.0884	0.1264	0.1521	0.0000	0.0000	0.0000	0.0494	0.0874	0.1131	0.0247	0.0627	0.1007	0.0123	0.0247	0.0627	0.0390	0.0770	0.1151
C5	0.0000	0.0257	0.0657	0.0000	0.0257	0.0637	0.1007	0.1388	0.1521	0.0370	0.0617	0.0874	0.0000	0.0000	0.0000	0.0247	0.0627	0.1007	0.0123	0.0380	0.0760	0.0257	0.0647	0.1027
C6	0.0751	0.1131	0.1388	0.0751	0.1131	0.1388	0.0617	0.0864	0.1121	0.0370	0.0627	0.0884	0.0617	0.0864	0.1121	0.0000	0.0000	0.0000	0.0637	0.1017	0.1398	0.0494	0.0874	0.1131
C7	0.0494	0.0874	0.1131	0.0380	0.0760	0.1141	0.0751	0.1131	0.1388	0.0494	0.0741	0.0988	0.0123	0.0370	0.0751	0.0504	0.0884	0.1264	0.0000	0.0000	0.0000	0.0370	0.0751	0.1131
C8	0.0874	0.1254	0.1388	0.1141	0.1521	0.1521	0.0884	0.1264	0.1521	0.0657	0.1017	0.1398	0.0627	0.1007	0.1264	0.0751	0.1131	0.1388	0.0760	0.1141	0.1398	0.0000	0.0000	0.0000

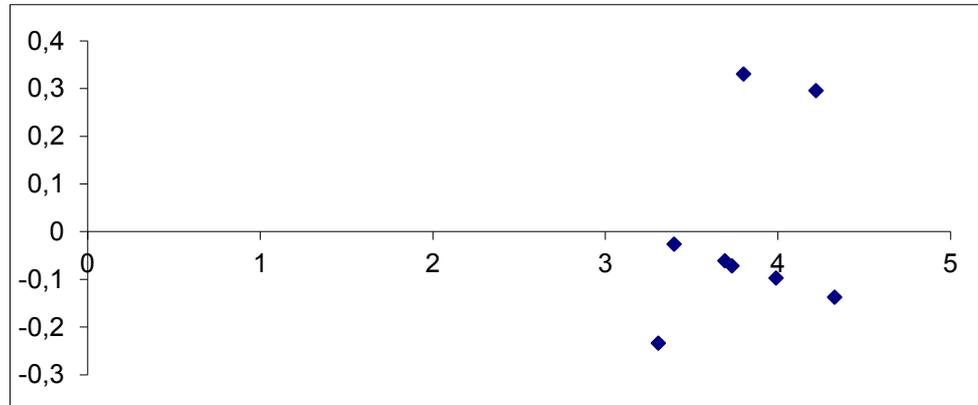
Table 5: Total Relation Matrix

	C1			C2			C3			C4			C5			C6			C7			C8		
	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U	L	M	U
C1	0.0370	0.1429	0.4878	0.1171	0.2636	0.6351	0.1295	0.3033	0.7451	0.0638	0.1766	0.5576	0.0541	0.1858	0.5678	0.1300	0.2882	0.7053	0.1399	0.2854	0.6752	0.1336	0.2824	0.6826
C2	0.0381	0.1518	0.4985	0.0303	0.1268	0.4655	0.1182	0.2807	0.6717	0.0668	0.1764	0.5113	0.1034	0.2170	0.5401	0.1032	0.2431	0.6142	0.0788	0.1975	0.5755	0.0757	0.2096	0.5955
C3	0.0755	0.2136	0.5931	0.0807	0.2171	0.6357	0.0574	0.1997	0.6388	0.1175	0.2483	0.6139	0.1186	0.2576	0.6164	0.1097	0.2674	0.7000	0.1073	0.2512	0.6665	0.0833	0.2343	0.6696
C4	0.0290	0.1411	0.4798	0.0444	0.1504	0.5141	0.1141	0.2515	0.6460	0.0221	0.0966	0.4017	0.0710	0.1853	0.5125	0.0474	0.1751	0.5605	0.0345	0.1313	0.5029	0.0564	0.1771	0.5545
C5	0.0151	0.1102	0.4243	0.0174	0.1176	0.4555	0.1188	0.2455	0.5994	0.0530	0.1455	0.4468	0.0202	0.0935	0.3739	0.0427	0.1615	0.5180	0.0304	0.1309	0.4740	0.0411	0.1536	0.5032
C6	0.0975	0.2258	0.5800	0.1056	0.2422	0.6221	0.1106	0.2631	0.6902	0.0680	0.1825	0.5391	0.0925	0.2123	0.5686	0.0397	0.1562	0.5398	0.0977	0.2347	0.6327	0.0810	0.2230	0.6209
C7	0.0692	0.1901	0.5338	0.0645	0.1933	0.5735	0.1089	0.2602	0.6759	0.0729	0.1783	0.5233	0.0402	0.1543	0.5126	0.0783	0.2173	0.6208	0.0294	0.1246	0.4802	0.0618	0.1940	0.5902
C8	0.1170	0.2661	0.6483	0.1518	0.3085	0.7064	0.1507	0.3422	0.8104	0.1028	0.2476	0.6507	0.1055	0.2395	0.6520	0.1225	0.2966	0.7419	0.1204	0.2790	0.7075	0.0446	0.1778	0.5989

Table 6: Values of  $\tilde{D}_i$ ,  $\tilde{R}_i$ ,  $D_i$ ,  $R_i$ ,  $D_i+R_i$  and  $D_i-R_i$

	$\tilde{D}_i$			$\tilde{R}_i$			D	R	D+R	D-R
	L	M	U	L	M	U				
C1	0.8047	1.9281	5.0765	0.4784	1.4415	4.2456	2.0666	1.7362	3.8028	0.3303
C2	0.6244	1.6028	4.4722	0.6138	1.6195	4.6279	1.8169	1.8779	3.6947	-0.0610
C3	0.7519	1.8892	5.1511	0.9181	2.1462	5.4725	2.0961	2.2335	4.3297	-0.1374
C4	0.4188	1.3085	4.1720	0.5687	1.4517	4.2565	1.6872	1.7132	3.4004	-0.0259
C5	0.3407	1.1583	3.7951	0.6054	1.5652	4.3537	1.5376	1.7712	3.3087	-0.2336
C6	0.6926	1.7397	4.7935	0.6735	1.8055	4.9999	1.9469	2.0440	3.9908	-0.0971
C7	0.5252	1.5122	4.5099	0.6384	1.6346	4.7147	1.8323	1.9036	3.7359	-0.0713
C8	0.9154	2.1771	5.5140	0.5775	1.6518	4.8135	2.2586	1.9626	4.2211	0.2960

Figure: Thecausaldiagram



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