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# Using DEMATEL – ANP hybrid algorithm approach to select the most effective dimensions of CRM on innovation capabilities

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| ARTICLE INFO | ABSTRACT |
|---|---|
| | Customer relationship management (CRM) and innovation are widely considered to be valuable capabilities associated with competitive advantage. CRM is a comprehensive guideline and process of management and data sharing with key customers to prompt supreme values of partnership and customers. Innovation is an important factor in setting successful mature firms apart from their competitors. Innovation capability assessments are methods to evaluate the innovation capability of enterprises, in particular, for the identification of their strengths, the improvement of their potentials, and for a good basis for a sustainable improvement of the innovation capability. The propose of this study is choosing the most effective dimensions of CRM by using the hybrid approach of Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP). Thus, based on experiences of the industry firm, we draw the causal relations among innovation capabilities using DEMATEL mathematical model and determine their effects on each other. Then based on these causal relations, we choose the most effective dimensions of CRM by using the ANP model. At the result, "long-term cooperation" has the best score and can be said that it is the most effective dimensions and And then respectively followed by Customer relationship management technology-oriented, Customer participation, information sharing and consultation on problems. |

## 1. Introduction

Customer relationship management (CRM) is a widely implemented strategy for managing a company's interactions with customers, clients and sales prospects. In the two last decades, CRM has become an important subject for business organizations from different sizes and fields. It describes a company-wide business strategy including customer-interface departments as well as other departments. Measuring and valuing customer relationship is critical to

implementing this strategy. CRM is a multi-perspective business paradigm that is comprised of people, process and technology (Chen and Popovich, 2003). CRM can be seen as the consistent organizational activity under usage of integrated selling, marketing and service strategy. That is, trying to define the real need of the customer, by the enterprise integrating various process and technology, in asking internal product and service improvement, to dawn effort of enhancing customer satisfaction and loyalty (Kalakota and Robinson, 1999). In 2001, Kalakota and Robinson also offered the concept of CRM system to synthesize with functions of sales, customer service, and marketing activity, all based on customer orientation. The same idea also served as the developmental foundation of CRM system upgrades in the present.

At present, the growth and development of the technology have caused most of the organizations to provide customers their products and services with high quality and low prices. By changing role of the customer (customers changing role) for the organization, from state of following producers, to leading manufacturers and other innovators, such idea cannot be assurance company's success in this environment. In these situations the customer is considered as a reliable competitive advantage for organizations. Nowadays, in the competitive world with domestic and foreign complex markets, the aims of organizations satisfy audience and customers by providing the needs of them. In today's extensive market success or failure of each organization depends on the type of relationship with customer and satisfaction of him. As a result, organizations to obtain satisfy customer's need and valuable competitive advantage, forced to promote innovation capabilities. But development and improvement of innovation capabilities to respond to demands of competitive markets have become an important issue for organizations. Customer is the core of any business activity.  The study of relationship management procedures with customer of all organizations and industrial settings are believed to be the underlying need of modern society. On the other hand, all agreed that one of the most complex things facing organization is innovation. Selecting the most effective dimensions of CRM on the innovation's capabilities in an organization is the aim of this study. In other words, we want to know which dimensions of CRM can transmit customer feedbacks more than the rest, in terms of upgrading the innovation capabilities in the organization. Because by increasing this dimension, company can be reach customer's practical points faster than other competitors. Responding to these comments and hearing the voice of the customer is the way to achieve suitable innovation. In principle, finding the most effective dimensions will help us to know in which dimensions of innovation should be more investment. And hereby, and having this valuable information can make the most effective innovation.

To draw the causal relations between innovation capabilities and determine their effects on each other, Decision Making Trial and Evaluation Laboratory (DEMATEL) model was used. Then based on these causal relations, we ranked five dimensions of CRM and chose the most effective dimensions of CRM by using Analytic Network Process (ANP).

## 2. Literature Review

### 2.1. Customer relationship management and innovation capability

In today's dynamic and unpredictable business environment, customers are considered to be the central element of all marketing objectives, and CRM has become a priority for organizations. CRM is increasingly important to firms as they look for improve their profits through longer-term relationships with customers and they have started developing and implementing CRM strategies. CRM is an integration of technologies, people and business processes that are applied to satisfy the customers' need, and to improve interactions with

clients (Bose, 2002; Foss et al., 2008; Becker et al., 2009). CRM principally revolves around marketing and begins with a deep analysis of customer behavior (Kotler, 1997).

Generally, there are two streams of CRM literature, the process of developing CRM and the content of CRM. Reinartz et al. (2004) divided CRM process into initiation, maintenance, and termination from the points of process view. In contrast, CRM content is related to various activities to enhance customer relationships, For instance, Sin et al. (2005) showed that CRM involves activities that manufacturer practice to satisfy customer needs, identify customer preferences, resolve customer complaints, provide after-sale service, and establish long-term relationships with their customers. In addition, McEvily and Marcus (2005) suggested that firms have to build mutual trust, information sharing, and joint problem solving with their customers to acquire competitive capabilities.

Innovation is an idea, practice, or object that is perceived as new to an individual or another unit of adoption (Fruhling and Siau, 2007). Green et al. (1995) also showed that innovation is a multi-dimensional concept where manufacturers focus on product, process, and service to implement gradual modification (e.g. product line expansion, current function, and minor adjustments in operation activities). Innovation capability refers to the implementation or creation of technology as applied to systems, policies, programs, products, processes, devices, or services that are new to an organization (Chang and Lee, 2008; Damanpour and Evan, 1984). Innovation capability is also the ability of firms to assimilate and utilize external information for transfer into new knowledge (Cohen and Levinthal, 1990).

There are two key aspects of innovation: the degree of innovation and the scope of innovation. The degree of innovation is differentiated into radical and incremental innovation. Radical innovation is a dramatic breakthrough in a new product, new market, or new technology (Green et al., 1995). Weerawardena (2003) considered innovation to be modification of product, process, service, organizational systems, and marketing systems in order to create customer value. The scope of innovation capability consists of technical innovation and administrative innovation (Damanpour, 1991). Technical innovations include products, marketing, services, and the technology used to produce products, product sales, or render services directly related to the basic work activity of an organization (Damanpour and Evan, 1984; Daft, 1982). Administrative innovation pertains to organizational structure and administrative processes, indirectly related to the basic work activity of the organization and is more directly related to its management (Damanpour and Evan, 1984).

Janbozorgi et al., (2015) present a framework to evaluate the readiness of hotels in terms of inter-organizational factors in order to implement CRM using fuzzy approach. Parsian Esteghlal Hotel employees, managers and experts constituted the study population. The importance of the indicators using Fuzzy ANP and DEMATEL integrated approach. The results showed that the readiness of Parsian Esteghlal Hotel to implement CRM in dimensions of culture, processes, and hardware, software and information systems was desirable and in dimensions of staff and managers was not desirable.

Shahhosseini et al. (2015) comparised the performance of organizations on CRM implementation by using an integrative approach of Fuzzy ANP and DEMATEL. it was include that integrative technology was the most important dimension, then respectively other dimension, which are CRM process, customer and output CRM.

In this study, five most popular CRM activities and six innovation capabilities that are included following:

**Table 1.**        CRM activities and innovation capabilities

| Dimensions of CRM | Innovation capabilities |
|---|---|
| **(1) Information sharing.**<br> It refers to the sharing and exchange of essential and exclusive information through interactive activities between manufacturers and their customers (McEvily and Marcus, 2005; Mentzer et al., 2000). The commonly shared information includes market demand, customer preferences, sales promotion, and new product introduction (Mentzer et al., 2000).<br>　　　-Market Information<br>　　　-Produce Information<br>　　　-Information Records<br>　　　- Programs offered Products<br>　　　-Event Information | **(1) Product innovation.**<br>It is the development and introduction of a new product to the market or the modification of existing products in terms of function, quality consistency, or appearance (Liao et al., 2007).<br>- New Product<br>-Production Supply Channel<br>-New Markets<br>-Special Markets |
| **(2) Customer participation**<br>It is related to customer participation in new product development activities, technical meetings, supply chain annual conference, and market evaluation conferences. Customers normally provide market trend/direction and technical support in the process, which should lead to better understanding of future demands (Sin et al., 2005).<br>　　　-Development of new products<br>　　　-Periodical review<br>　　　-Product improvement<br>　　　 -Market evaluation | **(2) Process innovation.**<br>It involves creating and improving the method of production, and the adoption of new elements to the firm's production process (Damanpour, 1996).<br>-Process technology<br>-Register patent<br>-Design equipment<br>-Process control Technology<br>-Advanced quality measurement system<br>- Programmable devices<br>-Programmable equipment |
| **(3) Long-term cooperation.**<br> It is a business relationship with trust and commitment between two firms. Both firms must share similar goals and pursue mutual profits on a reliable and dependable basis (Mohr and Spekman, 1994). Numerous studies have proven that a long-term partnership entails high degrees of commitment and mutual trust in which both parties are willing to provide resources, in a fair and dependable manner, in order to maintain and reach the goals of both parties (Handfield and Bechtel, 2002).<br>　　　-Commitment<br>　　　-Confidence<br>　　　-Special products<br>　　　-Customer loyalty<br>　　　-Communication<br>　　　-Long term communication development | **(3) Marketing innovation.**<br>It refers to market research, price-setting strategy, market segmentation, advertising promotions, retailing channels, and marketing information systems (Vorhies and Harker, 2000; Weerawardena, 2003).<br><br>Method of estimating price<br>　　-Distributions methods<br>　　-Market development Method<br>　　-CRM advanced System |
| **(4) Consultation on problems**<br> It refers to collaboration between manufacturers and customers in solving problems together and sharing responsibilities when they encounter difficult or unexpected situations (McEvily and Marcus, 2005).<br>　　- Overcome problems<br>　　-Sense of shared responsibility<br>　　- Settle problems | **(4) Service innovation.**<br>It refers to manufacturers' engagement in various innovation activities to enhance customer satisfaction, including after-sale services, warranty policy, maintenance routines, and order placement systems (Gopalakrishnan and Damanpour, 1997).<br>Modern After sales Service System<br>　　-Modern procedure debts settlement<br>　　-After and before sale services methods |
|  | **(5) Innovation in Sales**<br>　　-Sales management systems<br>　　-Different strategies sales |
| **(5) Customer relationship management technology-oriented**<br> It involves manufacturers using computer technologies to facilitate various CRM activities and actively offer technology assistance to customers, including data storage, data mining, and CRM software systems (Sin et al., 2005).<br>　　　-Information desk<br>　　　-Analyzed system<br>　　　-Management information System<br>　　　-Assessment performance system Customer Relationship Management | **(6) Administrative innovation.**<br>It refers to changes in organizational structure or administrative processes, such as the recruitment of personnel, the allocation of resources, and the structuring of tasks, authority, and rewards (Damanpour, 1992; Gopalakrishnan and Damanpour, 1997).<br>-Reward system<br>-New design<br>-Modern administrative structure<br>-Organizational structure extension<br>-Process reengineering |

## 2.2.    DEMATEL (Decision Making Trial and Evaluation Laboratory)

A decision making trial and evaluation laboratory (DEMATEL) is developed by Battelle Memorial Institute (BMI) (Gabus and Fontela, 1973; Fontela and Gabus, 1976) applied to the resolution of sophisticated issues. The DEMATEL method uses digraphs to categorize the influencing factors into two groups: cause group and effect group. There are five steps to perform the DEMATEL process:

**Step 1:** Calculate the scores and Produce the direct-influence matrix.

Define the scale to show the impact levels. Respondents were asked to indicate the direct effect that they believe each element i experts on each element j of others, as indicated by $X_{ij}$, using an integer scale (scores) arranging from 0 to 4; set the influence scales: 0 (no influence), 1 (low influence), 2 (medium influence), 3 (high influence), and 4 (very high influence). Next, the pair-wise comparisons are made according to influence and direction between criteria. Then, form the direct-influence matrix: a $n \times n$ matrix X, where $x_{ij}$ expresses the level of how the service attribute i affects service attribute j. The value of a diagonal line in this matrix is 0.

$$X = \begin{bmatrix} 0 & x_{12} & \cdots & x_{1n} \\ x_{21} & 0 & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & 0 \end{bmatrix} \tag{1}$$

**Step 2:** Calculate the normalized direct-influence matrix.

The normalized direct-influence matrix D is obtained by Eqs. (2) and (3), the matrix D is obtained by multiplying each element of A by the scalars. Note that each element $d_{ij}$ of matrix D is between zero and less than 1.

$$D = s.A \qquad S > 0 \tag{2}$$

Where

$$s = min\left[\frac{1}{\max_i \sum_{j=1}^n |a_{ij}|}, \frac{1}{\max_i \sum_{i=1}^n |a_{ij}|}\right] \qquad i,j = 1, \ldots, n. \tag{3}$$

**Step 3:** Compute the total relation matrix.

A continuous decrease of the indirect effects of problems along the powers of matrix D, e.g. $D^2, D^3, \ldots, D^\infty$ guarantees convergent solutions to the matrix inversion similar to an absorbing Markov chain matrix. Note that $\lim_{m \to \infty} D^m = [0]_{n \times n}$ and $\lim_{m \to \infty}(I + D + D^2 + D^3 + \cdots + D^m) = (I - D)^{-1}$, where 0 is the n×n null matrix and I is the n×n identity matrix. The total relation matrix T is an n×n matrix and is defined as follow:

$$T = [t_{ij}] \qquad i,j = 1,2, \ldots, n \text{ where}$$
$$T = D + D^2 + D^3 + \cdots + D^m \tag{4}$$
$$= D(I + D + D + D^2 + \cdots + D^{m-1})$$
$$= D[(I + D + D + D^2 + \cdots + D^{m-1})(1 - D)](1 - D)^{-1}$$

$$= (I - D)^{-1} , as \quad m \to \infty$$

We also define r and c as n×1 vectors representing the sum of rows and sum of columns of the total relation matrix T as follows:

$$r = [r_i]_{n\times1} = \left(\sum_{j=1}^{n} t_{ij}\right)_{n\times1} \tag{5}$$

$$c = \left[c_j\right]'_{1\times n} = \left(\sum_{j=1}^{n} t_{ij}\right)'_{1\times n} \tag{6}$$

Where superscript $'$ denotes transpose.

Let ri be the sum of i-th row in matrix T. Then ri shows the total effects, both direct and indirect, given by factor i to the other factors. Let $c_j$ denotes the sum of j-th column in matrix T. Then $c_j$ shows the total effects, both direct and indirect, received by factor j from the other factors. Thus when $j = i$, the sum $(r_i + c_i)$ gives us an index representing the total effects both given and received by factor i.

In other words, $(r_i + c_i)$ shows the degree of importance (total sum of effects given and received) that factor i plays in the system. In addition, the difference $(r_i + c_i)$ shows the net effect that factor i contributes to the system. When $(r_i + c_i)$ is positive, factor i is a net causer, and when $(r_i + c_i)$ is negative, factor i is a net receiver (Tzeng et al. 2007; Tamura et al., 2002).

**Step 4:** Set a threshold value and obtain the impact-relations-map.

In order to explain the structural relation between the factors while keeping the complexity of the system to a manageable level, it is necessary to set a threshold value p to filter out some negligible effects in matrix T. While each factor of matrix T provides information on how one factor effects another, the decision-maker must set a threshold value in order to reduce the complexity of the structural relation model implicit in matrix T. Only some factors, whose effect in matrix T is greater than the threshold value, should be chosen and shown in an impact-relations-map (IRM) (Tzeng et al., 2007).

In this paper, the threshold value has been obtained by average of scores of T matrix. As long as the threshold value has been decided, the final result can be shown in an IRM. If the influence level of an element in matrix T is higher than the threshold value, then this element is included in the final impact relations map.

### 2.3.    Analytic Network Process (ANP) Method

The ANP, a new theory extending from the AHP, is proposed by Saaty (1996). AHP model contains hierarchical relationship between overall goal, criteria, sub criteria and alternatives. But the problems don't always show hierarchical structure. In such a case, ANP structures the problem as network instead of hierarchical modeling. However in ANP, criteria in the lower level may provide feedback to the criteria in the higher level, and the interdependence between the criteria in the same level is permitted .Another difference between AHP and ANP in calculation process is that a new concept "super-matrix" is introduced in ANP. The application steps of ANP are as follows (Saaty, T.L., 1999).The ANP is composed of four major steps:

**Step 1:** Identify the Decision Criteria.

Firstly, criteria, sub criteria and alternatives are defined.

**Step 2:** Forming the Network Structure.

ANP uses a network without the need to specify levels as in a hierarchy. Generally, the system is divided into two parts: the control level and the network level under ANP. The control level

includes the goal and the decision criteria. The network level consists of the elements controlled by the control level. The structure can be obtained by the opinion of decision-makers through brainstorming or other appropriate methods. Network is formed based on relationship between clusters and within elements in each cluster. An example of the format of a network is shown in Figure 1(b).



(a)                    (b)
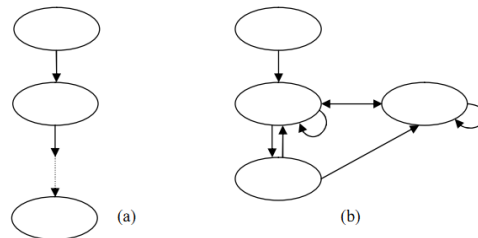
**Fig. 1.**              Structural difference between a hierarchy and a network.
(a) A Hierarchy (b) a Network

**Step 3:** Forming Pair-wise Comparison matrices and obtaining priority vector.

Pair-wise comparisons are performed on the elements within the clusters as they influence each cluster and on those that it influences, with respect to that criterion. The pair-wise comparisons are made with respect to a criterion or sub-criterion of the control hierarchy. Thus, importance weight of factors is determined. In pair-wise comparison, decision makers compare two elements. Then, they determine the contribution of factors to the result (Saaty, T.L., 2001).In ANP, like AHP, it is formed pair-wise comparison matrices with use 1-9 scale of relative importance proposed by Saaty.1-9 scale of relative importance is given at Table 2.

**Table 2.**     Scale of relative importance.

| Intensity of Importance | Definition |
| --- | --- |
| 1 | Equal importance |
| 3 | Moderate importance |
| 5 | Essential or strong importance |
| 7 | Very strong importance |
| 9 | Extreme importance |
| 2,4,6,8 | Intermediate value between adjacent scale values |

A reciprocal value is assigned to the inverse comparison; that is, $a_{ij} = \frac{1}{a_{ji}}$, where $a_{ij}(a_{ji})$ denotes the importance of the ith (jth) element.

Like AHP, The values of pair-wise comparisons are allocated in comparison matrix and local priority vector is obtained from eigenvector which is calculated from this equation:

$$A \times w = \lambda_{max} \times w \tag{7}$$

Where A is the matrix of pair-wise comparison, w is the eigenvector, and $\lambda_{max}$ is the largest Eigen value of A. Consistency of pair-wise matrix is checked by consistency index (CI). For accepted consistency, CI must be smaller than 0.10.

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{8}$$

$$CR = \frac{CI}{RI} \tag{9}$$

In the equations above, CI, RI and CR represent consistency indicator, random indicator and consistency ratio, respectively.

**Step 4:** Super-matrix formation.

For evaluating the weights of elements, the AHP uses the principal eigenvector of comparison matrix, while the ANP employs the limiting process method of the powers of the super-matrix. The super-matrix concept is similar to the Markov chain process (Saaty, T.L., 2005). To obtain global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix. As a result, a super-matrix is actually a partitioned matrix, where each sub-matrix represents a relationship between two nodes (components or clusters) in a system.

**Step 5:** Selection of the best alternatives.

It is able to determine importance weights of alternatives, factors and sub factors from limited super-matrix. The highest importance weight shows the best alternative.

## 2.4.    Research background

Table 3 is showing some researches in relationships between CRM capabilities field.

**Table 3.**               Some researches in relationships between CRM capabilities field.

|  | Year | Authors | Methodology and Results |
|---|---|---|---|
| **CRM & DEMATEL** | 2011 | Saeidipour and Ismaeli | This paper identifies and analyzes barriers of CRM implementation in SMEs. Hence, based on a comprehensive review of the literature and gathering the viewpoint of experts, the influencing barriers are identified. In order to analyze the identified barriers, DEMATEL methodology is applied and a causal model of the relationships between barriers is developed. Furthermore, based on the DEMATEL results the barriers are also categorized into two groups of driver and dependent. The results of study show that inadequate budget, organization culture, obligation of major management to CRM and inadequate access to modern technical knowledge are between effective impediments and play important role in successful establishment of customer relationship management system. |
| **CRM & ANP** | 2011 | Miri-Nargesi et al. | the purpose of this paper is to assess readiness of Iranian firms to implement CRM project. To achieve this purpose, with review of 51 key papers published between 2001 to 2010 and consensus and extraction of readiness assessment factors in the literature, check list included 14 readiness assessment factors of customer relationship management project has been developed. Then, the new model of readiness assessment factors of customer relationship management has been proposed. Because of the internal relationships between criteria's and network structures of the proposed model, fuzzy analytical network process has been utilized. The results of this study shows that "Top management commitment", "Project management capability", "Manage IT infrastructure", "Customer-oriented culture" and "Clearly defined CRM processes" is the top five readiness assessment factors. |
|  | 2011 | Oztaysi et al. | In this paper, CRM performances of three e-commerce companies operating in Turkey have been compared using ANP approach. For this purpose, based on an extensive literature review, a network structure has been built. The model has been established and ran in Super Decisions package. Sensitivity analyses have also been conducted. The results showed that the ranking between the alternatives are sensitive to changes in the parameters. To the knowledge of the authors, this paper is the first study which evaluates CRM performance of firms using ANP MCDM methodology. |
|  | 2011 | Sen, H. et al. | Today's organizations should have a good and trustworthy system implemented for the needs of interaction with their customers. One of the main tools that take care of such interactions is a Customer Relationship Management (CRM) system. Choosing the right CRM solution is never easy and there is a growing trend of CRM implementation failures all over the world. The purpose of this paper is to illustrate the important aspects of the CRM and to show how to use the Analytic Network Process (ANP) as a multiple criteria decision-making methodology in choosing the best CRM solution. |

| | Year | Authors | Methodology and Results |
|---|---|---|---|
| **CRM capability & Innovation** | 2008 | Ko et al. | The purpose of this study is to identify the status of Customer Relationship Management (CRM) adoption and explore the influence of organizational characteristics on the CRM adoption process in the Korean fashion industry. Using Rogers' [Rogers EM. Diffusion of innovation. New York: Free Press; 1995] innovation decision process model as the conceptual basis, this study surveyed 94 Korean fashion companies to investigate the persuasion, decision, and implementation stages of CRM adoption. Organizational variables included firm characteristics (size, strategy, maturity of information system), product characteristics (category, fashion position, seasonality), and CEO characteristics (age, education). The most frequently used CRM technology is the development of a customer database, whereas the mostly frequently mentioned benefits of CRM are encouraging repurchase. Moreover, respondents' perceptions of CRM benefits affect CRM adoption, influencing the use of various CRM technologies. Organizational strategy, maturity of information system, and product category all significantly influence the adoption process. Empirical findings provide further support for the innovation decision process model developed by Rogers [Rogers EM. Diffusion of innovation. New York: Free Press; 1995] and the CRM adoption model can be used when fashion companies do strategic planning and evaluate the possibility of adopting CRM strategies. |
| | 2009 | Lin et al. | The purpose of this paper is to investigate the effects of various dimensions of customer relationship management (CRM) on innovation capabilities. Five dimensions of CRM (information sharing, customer involvement, long-term partnership, joint problem-solving, and technology-based CRM) and five aspects of innovation capability (product, process, administrative, marketing, and service innovations) are identified. The one-to-one associations between the two constructs are developed and verified. Data from 107 Taiwanese computer manufacturers are collected. Multiple regression analysis is employed to examine the effects of CRM on innovation capabilities. The following results are offered: computer manufacturers in Taiwan perform various levels of CRM and, consequently, display different levels of effects on each of the five innovation capabilities. Generally, firms are able to increase their innovation capability by ad hoc CRM; the relationship between customer involvement and process innovation; customer involvement and administrative innovation; and long-term partnership and marketing innovation are not significant; and technology-based CRM has positive effects on all five types of innovation. |
| | 2010 | Battor and Battor | Customer relationship management (CRM) and innovation are widely considered to be valuable capabilities associated with competitive advantage. However, there is a lack of research demonstrating how they work together to produce performance advantages. This research investigates the mediating role of innovation between CRM and performance. The authors examine the direct impact of both CRM and innovation on firm performance. Moreover, they investigate the role of innovation as a mediating mechanism to explain the effect of CRM on performance. The authors use structural equation modeling to test the relationships between these constructs. The results support the direct impact of CRM and innovation on performance. Also, the findings indicate that the indirect effect of CRM on firm performance through innovation is significant. These results reinforce the view that developing close relationships with customers enhances a firm's ability to innovate. |
| | 2014 | TOMA Et al. | Authors provide answers to a series of questions of topical interest and specialized theory regarding the customer relationship management (CRM) and its intersection with innovation capability, in order to learn how the two concepts co-exist, affect and transform each other. Five dimensions of CRM (information sharing, customer involvement, long-term partnership, joint problem-solving, and technology-based CRM) and five aspects of innovation capability (product, process, administrative, marketing, and service innovations) will be identified and explained. |

### 3.3. Methodology

The research methodology is consisted of two main phases which the process is presented in figure 2:

Phase 1.Modeling and deployment of DEMATEL method.

In this phase the interrelations within innovations will be understood by deployment of DEMATEL method.

Phase 2.Deployment of ANP for select the most effective dimensions of CRM

In final phase ANP method will be used on network made by DEMATEL for prioritizing five dimensions of CRM and then selecting the most effective dimensions of CRM on innovation.

## 4. AN EMPIRICAL STUDY

In this section, DEMATEL method is first employed to develop the network structure. The ANP is further used to compute the limiting super-matrix to rank alternatives.
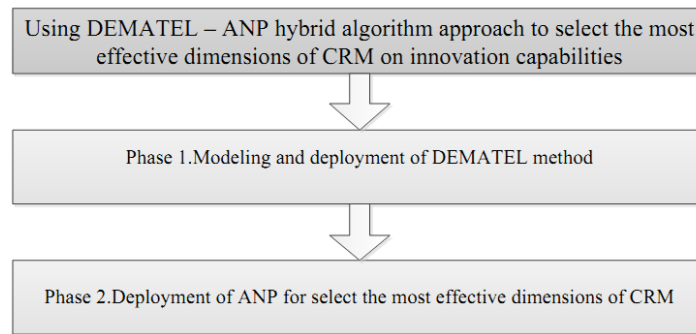


**Fig. 2.**                    Research methodology

**Table 4.**              The direct-influence matrix **A**

| Criterion | Process | Product | Marketing | Sales | Service | Administrative |
|---|---|---|---|---|---|---|
| Process | 0 | 3 | 4 | 3 | 4 | 4 |
| Product | 4 | 0 | 3 | 4 | 4 | 4 |
| Marketing | 3 | 3 | 0 | 4 | 4 | 3 |
| Sales | 3 | 4 | 4 | 0 | 4 | 3 |
| Service | 4 | 4 | 3 | 4 | 0 | 3 |
| Administrative | 4 | 4 | 3 | 4 | 3 | 0 |

**Table 5.**              The normalized direct-relation matrix **D**

| Criterion | Process | Product | Marketing | Sales | Service | Administrative |
|---|---|---|---|---|---|---|
| Process | 0 | 0.159 | 0.212 | 0.159 | 0.212 | 0.212 |
| Product | 0.212 | 0 | 0.159 | 0.212 | 0.212 | 0.212 |
| Marketing | 0.159 | 0.159 | 0 | 0.212 | 0.212 | 0.159 |
| Sales | 0.159 | 0.212 | 0.212 | 0 | 0.212 | 0.159 |
| Service | 0.212 | 0.212 | 0.159 | 0.212 | 0 | 0.159 |
| Administrative | 0.212 | 0.212 | 0.159 | 0.212 | 0.159 | 0 |

**Table 6.**              The total-influence matrix **T**

| Criterion | Process | Product | Marketing | Sales | Service | Administrative |
|---|---|---|---|---|---|---|
| Process | 3.346 | 3.490 | 3.367 | 3.637 | 3.680 | 3.360 |
| Product | 3.689 | 3.521 | 3.490 | 3.849 | 3.856 | 3.521 |
| Marketing | 3.329 | 3.337 | 3.046 | 3.514 | 3.521 | 3.175 |
| Sales | 3.490 | 3.535 | 3.373 | 3.507 | 3.689 | 3.329 |
| Service | 3.535 | 3.541 | 3.344 | 3.688 | 3.521 | 3.337 |
| Administrative | 3.535 | 3.541 | 3.344 | 3.688 | 3.659 | 3.2 |

**Table 7.**        The sum of influences given and received on criteria.

| Criterion | $r_i$ | $c_i$ | $r_i + c_i$ | $r_i - c_i$ |
|---|---|---|---|---|
| Process | 20.881 | 20.925 | 41.806 | -0.44 |
| Product | 21.927 | 20.967 | 42.894 | 0.96 |
| Marketing | 19.922 | 19.964 | 39.886 | -0.42 |
| Sales | 20.925 | 21.884 | 42.809 | -0.004 |
| Service | 20.967 | 21.927 | 42.894 | -0.96 |
| Administrative | 20.967 | 19.922 | 40.889 | 1.045 |

This case study the threshold value used in step 4 is to compute the average of the elements in matrix T, which is 3.489. Based on Table 6, there are four criteria which have the influence on process but the contribution of sales is the smallest. Thus, people are not a necessity. In contrast, product is the one more essential criterion to strengthen process. The findings based on Table 7 indicated that, product and service criteria with the same value of 42.894 are the important between other criteria, while Marketing is the least important criterion with the value of 39.886.

Whereas process, marketing, sales and service criteria are net receivers based on $(r-c)$ values. Also, base on this Table, in contrast to the product and administrative are net causer, the cause and effect diagram is showed in figure 3.

In Figure 3, the mutual relationship between process, product, sales, service is observed.

After specifying the causal relations using DEMATEL method, ANP algorithm will be applied to this network in order to prioritize five dimensions of CRM. The main objective which is to select the most effective dimensions placed on the topmost level of the model. Second level consists of the main criteria that affect the selection of the best Alternative. There are five dimensions of CRM which are evaluated at the lowest level (Figure 4). In this model the relationship between clusters and criteria are identified even they aren't hierarchical. The links between elements affect each other. A relationship exists between clusters and the elements within the clusters. These clusters and elements are then introduced to the software, and the evaluation is held by pair-wise comparisons. The number of comparisons is related to the connected nodes in each cluster.  Priorities obtained from the pair-wise comparison matrix (Table 8), as the shown in Figure 5.The un-weighted super-matrix is constructed after weighting that matrix with the component matrix, and finally, we obtain the limit super-matrix, represented as follows: The un-weighted, weighted and limit super-matrix for this model is shown in Tables 9 ,10 and 11 respectively. Limit super matrix shown in Table 11 is obtained from the weighted super matrix by raising it to powers until it converges and shows the importance weights of sub factors, factors and alternatives. All columns in this limiting super matrix are identical.
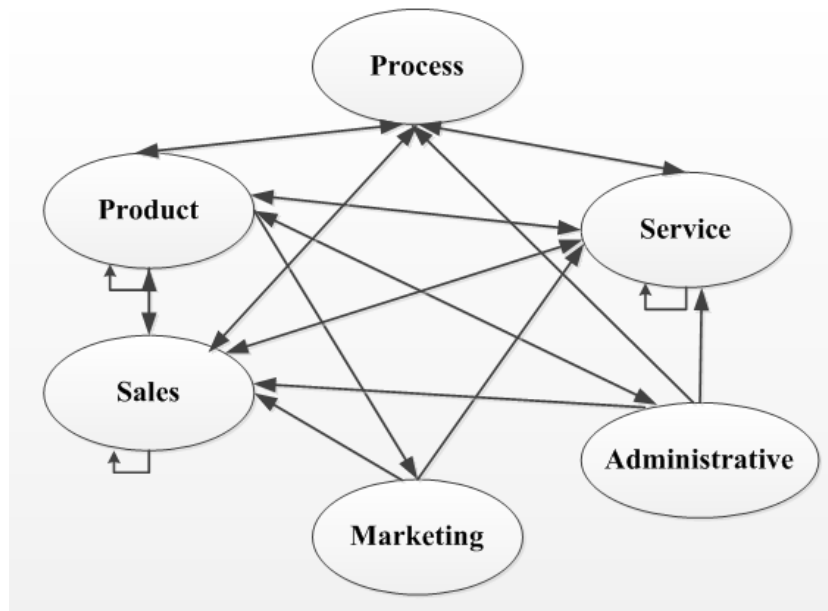
**Fig. 3.**    Network relationship map based on the threshold value p = 3.489
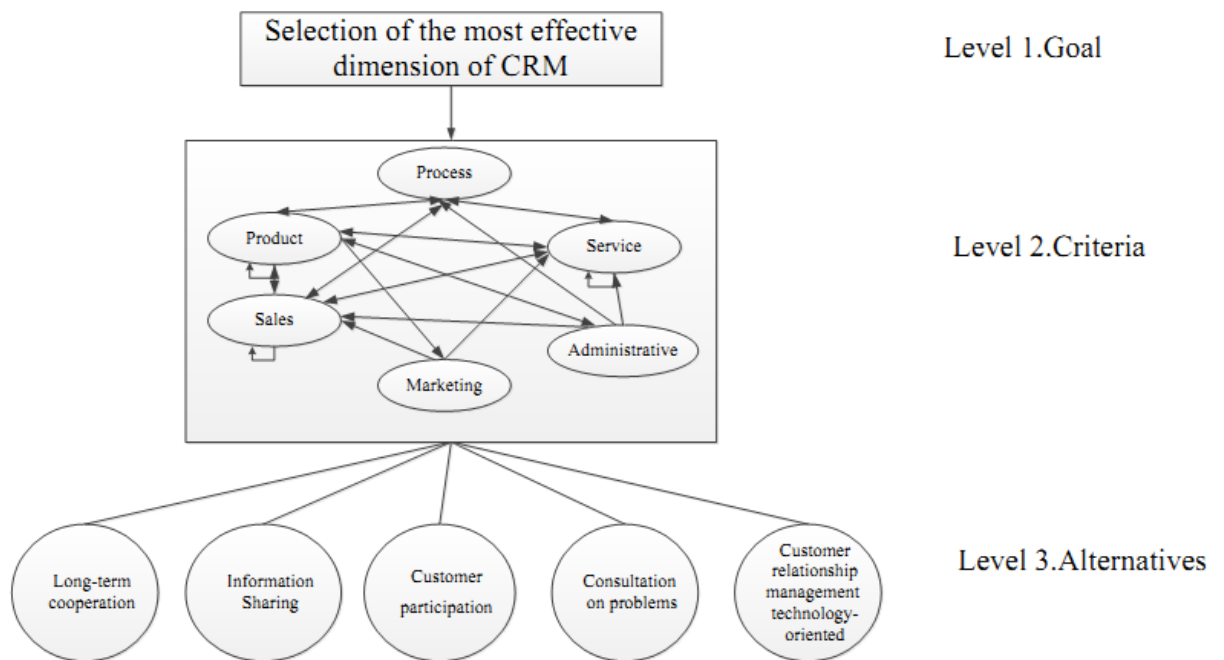


**Fig. 4.**    The Network Structure of the proposed model.

**Table 8.**          Pair-wise comparison matrix respect to alternatives
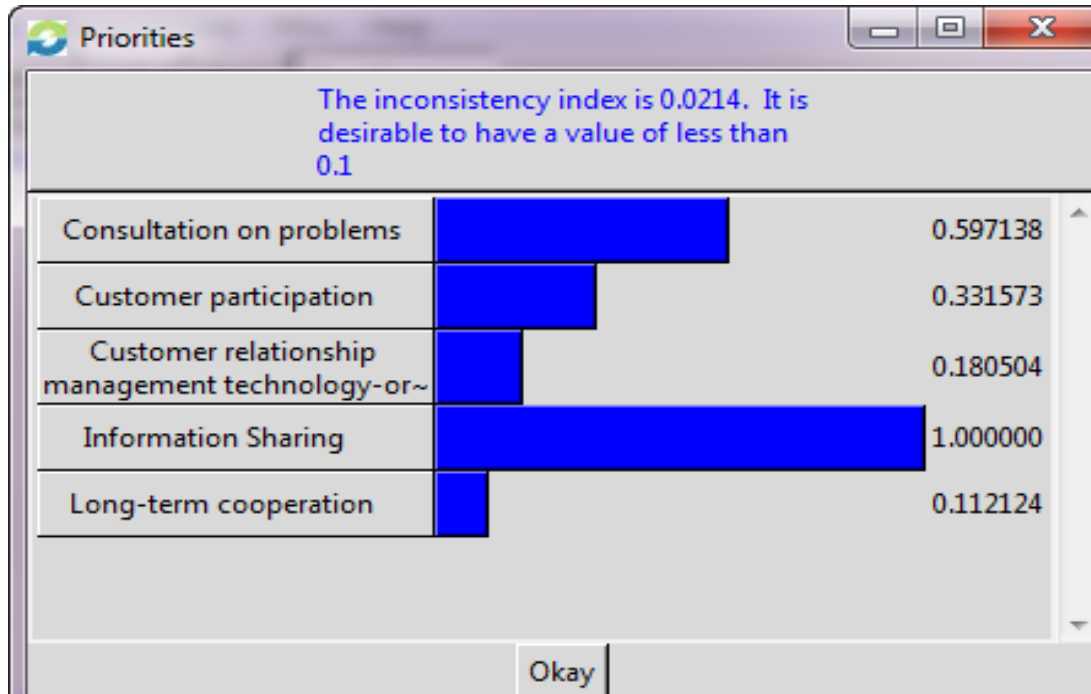




**Fig. 5.**    Process's priorities relative to Alternatives.

**Table 9.**            Un-weighted Super-matrix.

| | Consult~ | Custome~ | Custome~ | Informa~ | Long-te~ | Adminis~ | Marketi~ | Process | Product | Sales | Service |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Consult~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.05048 | 0.04892 | 0.26882 | 0.05048 | 0.05048 | 0.08126 |
| Custome~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.08126 | 0.08045 | 0.14927 | 0.45018 | 0.14927 | 0.05048 |
| Custome~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.26882 | 0.20937 | 0.08126 | 0.08126 | 0.26882 | 0.26882 |
| Informa~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.45018 | 0.45381 | 0.45018 | 0.14927 | 0.08126 | 0.14927 |
| Long-te~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.14927 | 0.20745 | 0.05048 | 0.26882 | 0.45018 | 0.45018 |
| Adminis~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.03883 | 0.00000 | 0.00000 |
| Marketi~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.24727 | 0.00000 | 0.00000 |
| Process | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.52193 | 0.00000 | 0.00000 | 0.05708 | 0.07189 | 0.07274 |
| Product | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.29280 | 0.00000 | 0.62501 | 0.39611 | 0.13238 | 0.12263 |
| Sales | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.11374 | 0.75000 | 0.23849 | 0.16177 | 0.55378 | 0.30052 |
| Service | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.07154 | 0.25000 | 0.13650 | 0.09893 | 0.24195 | 0.50411 |

**Table 10.**            Weighted Super-matrix.

| | Consult~ | Custome~ | Custome~ | Informa~ | Long-te~ | Adminis~ | Marketi~ | Process | Product | Sales | Service |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Consult~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.02524 | 0.02446 | 0.13441 | 0.02524 | 0.02524 | 0.04063 |
| Custome~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.04063 | 0.04022 | 0.07463 | 0.22509 | 0.07463 | 0.02524 |
| Custome~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.13441 | 0.10469 | 0.04063 | 0.04063 | 0.13441 | 0.13441 |
| Informa~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.22509 | 0.22691 | 0.22509 | 0.07463 | 0.04063 | 0.07463 |
| Long-te~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.07463 | 0.10372 | 0.02524 | 0.13441 | 0.22509 | 0.22509 |
| Adminis~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.01941 | 0.00000 | 0.00000 |
| Marketi~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.12364 | 0.00000 | 0.00000 |
| Process | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.26096 | 0.00000 | 0.00000 | 0.02854 | 0.03595 | 0.03637 |
| Product | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.14640 | 0.00000 | 0.31251 | 0.19806 | 0.06619 | 0.06131 |
| Sales | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.05687 | 0.37500 | 0.11924 | 0.08088 | 0.27689 | 0.15026 |
| Service | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.03577 | 0.12500 | 0.06825 | 0.04947 | 0.12097 | 0.25206 |

**Table 11.**            Limit Super-matrix.

| | Consult~ | Custome~ | Custome~ | Informa~ | Long-te~ | Adminis~ | Marketi~ | Process | Product | Sales | Service |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Consult~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.03647 | 0.03647 | 0.03647 | 0.03647 | 0.03647 | 0.03647 |
| Custome~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.09073 | 0.09073 | 0.09073 | 0.09073 | 0.09073 | 0.09073 |
| Custome~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.10699 | 0.10699 | 0.10699 | 0.10699 | 0.10699 | 0.10699 |
| Informa~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.08034 | 0.08034 | 0.08034 | 0.08034 | 0.08034 | 0.08034 |
| Long-te~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.18547 | 0.18547 | 0.18547 | 0.18547 | 0.18547 | 0.18547 |
| Adminis~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00411 | 0.00411 | 0.00411 | 0.00411 | 0.00411 | 0.00411 |
| Marketi~ | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.02616 | 0.02616 | 0.02616 | 0.02616 | 0.02616 | 0.02616 |
| Process | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.03215 | 0.03215 | 0.03215 | 0.03215 | 0.03215 | 0.03215 |
| Product | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.10577 | 0.10577 | 0.10577 | 0.10577 | 0.10577 | 0.10577 |
| Sales | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.19361 | 0.19361 | 0.19361 | 0.19361 | 0.19361 | 0.19361 |
| Service | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.00000 | 0.13820 | 0.13820 | 0.13820 | 0.13820 | 0.13820 | 0.13820 |

## 5. Findings

Finally, we obtained score of projects, which are represented by raw values, from limit super-matrix table. To get normal values, raw values are summed up and every row in raw column is divided by the sum. To obtain ideal values, every value in raw values column is divided by the greatest value of the column. The final ranking of the projects is presented in Figure 6.
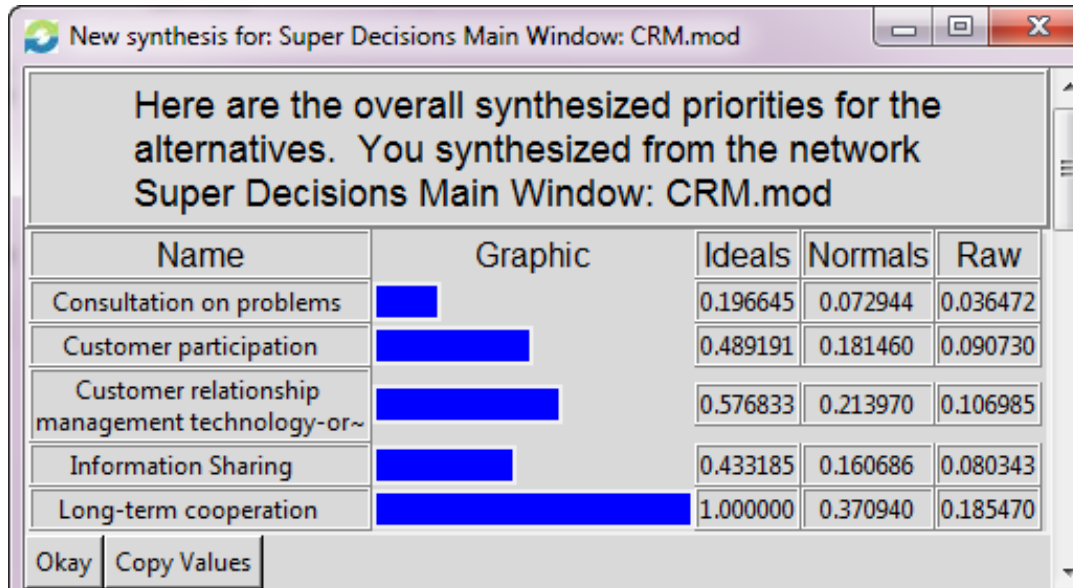
**Fig. 6.** The results of the proposed model.

It can be clearly seen that "long-term cooperation" has the best score and can be said that it is the most effective dimensions and followed by customer relationship management technology-oriented, customer participation, information sharing and consultation on problems.

The findings show that long-term cooperation is the most effective dimensions of CRM on increasing innovation capabilities. Therefore, it is necessary to in corporate strategic planning consider customer managers as an important element of information and has a long time view of customer. Ramani and Kumar (2008) using CRM to engage in creating, maintaining, and fostering useful customer relationships and keeping long-term partnerships are important strategic elements for developing innovation capability. Intensive interaction between manufacturers and customers encourage customers to provide valuable suggestions for product development (Droge et al., 2004).

The second dimension in terms of its influence on increasing innovation capabilities is customer relationship management technology-oriented. Information technology through the ease and speed in establishing communication with the customers has the significant impact on long-term relationship with customers.

The third effective dimension is customer participation. Customer participation can be defined as the specific behaviors, degree of consumer's effort and involvement, both mental and physical that relate to the production and delivery of a service. When a customer sees himself in position that is trusted by the company he will be encouraged to have long-term cooperation in the various fields. Engage key customers in the process of adopting the decisions of the company in the field of the development of new services, the revised operation of the company, improving services and periodic market assessment, technology of information processing can provide fields of increasing innovation capabilities in company. Customers partnership creates effective innovations for companies. Information received from customers at the continuous time is definitely much more effective in compared with sectional time.

The forth effective dimension is exchanging and sharing information with customers. Especially by using of Information technology, information sharing between customer and the company will make more Long-term partnership with customer.

The last effective dimension is partnerships between the Organization and customers to solve problems and to share responsibility when the incidence of the problem or face of the unexpected and difficult conditions.

## 6. Conclusion

Relationship management procedures with customer and innovation are the concern of organizations. Therefore, selecting the most effective dimensions of CRM on the innovation's capabilities in an organization is important topic that we study in this paper. CRM is as an imperative strategy to improve a firm's innovation capability and to enhance a firm's competitive advantage. Based on experiences of the industry firm, we draw the causal relations among innovation capabilities using DEMATEL mathematical model and determine their effects on each other. Then based on these causal relations, we ranked the improvement projects using ANP model. According to Table 7, administrative has highest $(r - c)$ and it is the most direct effectiveness to others and also product and services is net receiver based on $(r + c)$ values. At the result, in this paper via DEMATEL and ANP the most effective of dimensions of CRM has been selected. Finally, "long-term cooperation" has the best score and can be said that it is the most effective dimensions and followed by Customer relationship management technology-oriented, Customer participation, information sharing and consultation on problems.

There were some limitations in this research project. For example, the effectiveness of five dimensions of CRM on innovation capabilities has been implemented in one industry firm, it is better to implement in several industries. If the model were implemented in more firms, the results were probably more accurate. Another limitation, were the direct-influence matrix (Table 4) and Pair-wise comparison matrix improvement projects respect to the criteria built based on the thoughts, comments, and suggestions of experts.

For the future research, someone can use VIKOR method instead of ANP in the third phase (Deployment of ANP for ranking the dimensions of CRM) and compare the results with the ones presented in this paper.

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