

Identifying and Prioritization Effective Factors in New product development Using ANP & DEMATEL Methods in an Automotive Industry (Saipa industrial company)

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Abstract: In this study try to Identifying and Prioritization Effective Factors in New product development and the impact of these factors on each Using DEMATEL and ANP Methods. To identify critical influential factors, the authors studied and reviewed relevant literature from numerous fields of study associated with the essential issues of new product development. Results of the ANP method shows that Technological factors, Management and Staff factors, Commercialization, factors Organizational factors and Marketing factors are the most important factors in new product development. Results of the DEMATEL method show that Management and Staff have great impact on success of NPD implementation among main aspects. Among criteria of Management and Staff , Motivation in Product development team members has Great Influence on other criteria. Among criteria of Technological factor, Production in Time and cost Appropriate has Great Influence on other criteria. Among criteria of marketing factor, Focus on the customer has Great Influence on other criteria. Among criteria of Organizational factors , cooperation of Different levels has Great Influence on other criteria. Also , among criteria of Commercialization factor , Product superior to competitors has Great Influence on other criteria.

[Heidarinezhad M, Fathi Hafshejani K, Movahedi M.M. **Identifying and Prioritization Effective Factors in New product development Using ANP & DEMATEL Methods in an Automotive Industry (Saipa industrial company)**. *Nat Sci* 2013;11(11):155-163]. (ISSN: 1545-0740). <http://www.sciencepub.net/nature>. 22

Keywords: New product development, Multi-criteria decision making, Analytic Network Process, DEMATEL

1. Introduction

Today's world is characterized by major changes in market and economic conditions, coupled with rapid advances in technologies. Management is often confronted with the dilemma whether or not to invest in a particular stage of the new product development (NPD) program, given market and technology uncertainties surrounding such a decision in current markets, most of all technology-driven or high-tech markets (Moriarty and Kosnik, 1989). The new product development (NPD) and innovation are often recognized as the key processes of competition in a variety of markets (Brown and Eisenhardt, 1995; Drucker, 1999; Hamel and Prahalad, 1994; Jones, 1997; McQuater et al., 1998). Today, markets are generally perceived to be demanding higher quality and higher performing products, in shorter and more predictable development cycle-times and at lower cost (Maffin and Braiden, 2001). NPD is defined as the transformation of a market opportunity and a set of assumptions about product technology into a product available for sale (Krishnan and Ulrich, 2001).

NPD is an interdisciplinary activity (Davila, 2000) including marketing management, organizations, engineering design, operations management and requires contributions from nearly all the functions of an enterprise, whether it is an upgrade (an improvement of an existing product) or a

new concept either to the company or to the market (Haque et al., 2000). The core of the NPD process centers on knowledge, it's creation, utilization and the management of knowledge. Within the context of the knowledge-base firm, knowledge has a critical strategic value since it fosters organizational actions and helps the firm establish sustainable competitive advantage. Organizational knowledge is a unique asset and a scarce commodity of an organization. Yet, creating, replicating and transferring knowledge within NPD teams, between NPD teams, and between organizational units is difficult to carry out. Managing knowledge and knowledge creation is a complex task that gives rise to multiple organizing and management issues.

New product development (NPD) can originate from new technology or new market opportunities (Eliashberg et al., 1997). But irrespective of where opportunities originate, when it comes to successful new products it is the consumer who is the ultimate judge (Brown and Eisenhardt, 1995; Cooper and Kleinschmidt, 1987). So, in order to develop successful new products, companies should gain a deep understanding of 'the voice of the consumer'. Consumer research can be carried out during each of the basic stages of the NPD process: (1) opportunity identification, (2) development, (3) testing, and (4) launch (Suh, 1990; Urban and Hauser, 1993). It is most widely applied during the

development, testing and launch stages. Even the most technologically oriented companies use consumer research to verify that consumers will accept a new product when it will be launched at the market. NPD can be considered as an incremental process in which incremental investments provide options to proceed in the process. Moreover, when the R&D stages are completed, the option of market launching the new product is created.

Virtual NPD in SMEs is in its infancy in developing countries, and little research has been done on the introduction of the NPD in SMEs through a virtual team. So, we formed the topic that is somewhat lacking in the literature as a research gap. For many firms innovation is an important business driver. This being the case, managers are pressed to design effective organisational structures to support these activities – which unfortunately – also are widely known to be difficult to organize and manage.

2. NEW PRODUCT DEVELOPMENT (NPD)

New product development (NPD) is crucial in various industries for shortening a product's time to market and for improving the product's quality. The literature provided a number of definitions for what constitute a new product development. Product development definition is used by different researchers in slightly different ways (Ale Ebrahim et al., 2009). Generally, it is the process that covers product design, production system design, product introduction processes and start of production (Johansen, 2005). Loch and Kavadias (2008) in the "Handbook of New Product Development Management" define NPD to "consists of the activities of the firm that lead to a stream of new or changed product market offerings over time. This includes the generation of opportunities, their selection and transformation into artifacts (manufactured products) and activities (services) offered to customers and the institutionalization of improvements in the NPD activities themselves".

New product development is widely recognized as an essential property of the firm (Lam et al., 2007). Life cycle of products is decreasing every year and the customer demand, on the other hand, increased dramatically. With the need to respond quickly to customer requirements, increased complexity of product design and rapidly changing technologies, selecting the right set of NPD is critical to long-term success of the firm (Chen et al., 2008). NPD can be defined as a process including many "generic decision" points, likewise "decision perspective" of Krishnan and Ulrich (2001). In their related work, Urban and Hauser (1993) recommend a five-step decision process for NPD: opportunity

identification, design, testing, introduction and life cycle management.

New product development is of high importance for both large and small and medium sized organizations (Pullen, de Weerd-Nederhof et al. 2008)." "Small- and medium sized organizations (SMEs) have a number of typical problems with regard to their innovation process, especially in the shift from the development stages to the commercialization stages (Hanna and Walsh 2002)." Product innovation work is mainly driven by market needs and ultimately external customers. Thus, the product innovation work is primarily effectiveness-driven. Respectively, process innovation work is mainly driven by the needs of production (i.e. internal customers) and can be said to be primarily efficiency-driven. Important to note, these strict definitions and separation of product and process innovation activities do not, however, imply that there cannot be a combination of the two activities and objectives in an innovation project. There are a few investigators done to evaluate NPD performance. For example, (Cooper et al., 2004) discover different measures of NPD performance at the project levels and various plans (Cooper, Edgett et al. 2004). "Measures of the performance of the entire NPD program include the percentage of business profits from new products and the All of these measures show that NPD brings positive growths. With some exceptions, there is general agreement that the new product development (NPD) process is not adequately studied in small and medium enterprises (SMEs) and models and tools specifically focused for these units are lacking. This deficiency is particularly evident where SMEs located in industrial districts are concerned (De Toni and Nassimbeni 2003)."

3. Effective Factors in New product development

Proficiency in NPD can contribute to the success of many companies. According to Poolton and Barclay (1998), 'if companies can improve their effectiveness at launching new products, they can double their bottom line. It's one of the areas left with the greatest potential for improvement.' Lynn et al. (1999) developed a model of the determinants of new product development success. Lester's (1998) study identified a range of potential problems that can derail well-intentioned NPD efforts. By working through these problems, Lester discovered 15 CSFs in five areas of new product development. Poolton and Barclay (1998) identified a set of six variables that have consistently been identified in the literature as being associated with successful NPD. Cooper and Kleinschmidt (1995) studied hundreds of cases to reveal what makes the difference between winners and losers in the process of NPD. He extracted 12 common denominators of successful new product

project and seven possible reasons (blockers) offered by managers for why the success factors are invisible and why projects seem to go wrong or are otherwise not well executed.

Based on the previous literature review, we focus on five main aspects including Management

and Staff , Technical factors, Marketing factors, Organizational factors and Commercialization. From these main aspects, 21 Effective Factors in New product development are maintained. The classification of those main Criteria and their Sub-Criteria are shown in Table 1.

Table 1. Effective Factors in New product development

Criteria	Sub-Criteria	Reference
Management and Staff	Senior management commitment	Lynn et al. (1999), Lester (1998), Poolton and Barclay (1998), Cooper (1999) Sun and Wing (2005)
	Flexibility and responsiveness to change	Cooper (1999) Sun, Poolton and Barclay (1998)
	Motivation in Product development team members	Poolton and Barclay (1998)
	Risk in decision-making	Haverila(2012), Poolton and Barclay (1998)
Technical factors	Technical capabilities	Cooper (1999) Sun and Wing (2005), Poolton and Barclay (1998)
	Product Production in Appropriate Time and cost	Cooper (1999), Sun Lynn et al. (1999) and Wing (2005), Lester (1998)
	Clear definition of the functions of the product	Cooper (1999) Gupta and Wilemon (1990)
	Technically difficult to replace	Sun Lynn et al. (1999), Lester (1998)
Marketing factors	Appropriate Marketing strategy	Lester (1998), Haverila(2012), Ernst Holger (2002)
	Focus on the customer	Cooper (1999) Sun, Wing (2005), Haverila(2012), Ernst Holger (2002)
	A growing market	Poolton and Barclay (1998), Ernst Holger (2002) Sharma (2006)
	Clear definition of the target market	Lester (1998), Cooper (1999) Sun and Wing (2005), Ernst Holger (2002)
Organizational factors	Long-term vision	Cooper (1999) Sun and Wing (2005)
	Different levels of cooperation	Cooper (1999), Haverila(2012), Haverila(2012), Wing (2005)
	Entrepreneurial culture in the organization	Wing (2005), Poolton and Barclay (1998)
	The time of replacement	Sun Lynn et al. (1999), Lester (1998)
Commercialization	Appropriate timing for the project	Haverila(2012), Cooper (1999) Sun and Wing (2005)
	Product Scores than competitors	Sun Lynn et al. (1999), Sharma (2006)
	Resources to implement the project	Lester (1998), Cooper (1999) Sun and Wing (2005)
	product developed Scores than The old type	Sun Lynn et al. (1999)
Commercialization	Generating good ideas by Expert Groups	Wing (2005), Haverila(2012), Sun Lynn et al. (1999), Lester (1998)

4. Data analysis

In this study the ANP method is used to Prioritization Effective Factors in New product development. In this section, an empirical study is presented to illustrate the application of the solution for Prioritization Effective Factors in New product development. The calculations of the supermatrix can be solved by using Microsoft Excel. The overall weights from the limit supermatrix are shown in Table 2. Also, final prioritization of criteria and sub-criteria is shown in table 3. In terms of criteria we have considered four items of the Technical factors, Management and Staff, Commercialization, Organizational factors and Marketing factors and the normalized weights of these factors are 0.269, 0.231, 0.197, 0.168 and 0.136 respectively. In other words, Technical factor is the most important factor, followed by Quality, Flexibility and Delivery time. As we discussed, this items includes 21 sub-criteria. The normalized weights of sub-criteria are shown in table 3. Technical capabilities is the most important sub-criteria with weight of 0.0879, followed by Motivation in Product development team members with weight of 0.0851, Resources to implement the project with weight of 0.0743 etc.

Table 2. The Limited Weighted Super-matrix

	A	B	C	D	E	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	D5	E1	E2	E3	E4
A	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048

Table 3: Final Prioritization of Criteria and Sub-criteria

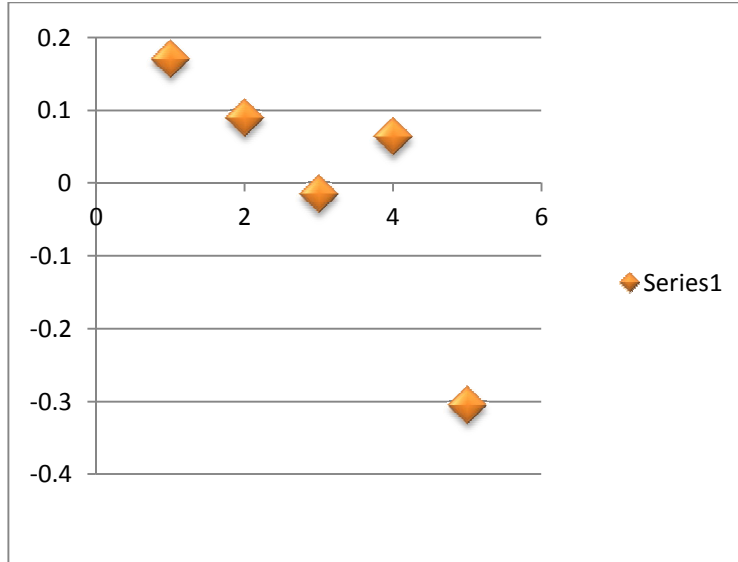
Criteria and Sub-criteria	Prioritization based on limited weighted super matrix	Prioritization of un-weighted	Priority
Management and Staff (A)	0.048	0.231	2
Technical factors (B)	0.056	0.269	1
Marketing factors (C)	0.028	0.136	5
Organizational factors (D)	0.035	0.168	4
Commercialization (E)	0.041	0.197	3
Senior management commitment (A1)	0.052	0.0714	4
Flexibility and responsiveness to change (A2)	0.041	0.0563	7
Motivation in Product development team members (A3)	0.062	0.0851	2
Risk in decision-making (A4)	0.019	0.0261	19
Technical capabilities (B1)	0.065	0.0879	1
Product Production in Appropriate Time and cost (B2)	0.024	0.0330	15
Clear definition of the functions of the product (B3)	0.021	0.0288	17
Technically difficult to replace (B4)	0.032	0.0439	11
Appropriate Marketing strategy (C1)	0.017	0.0235	20
Focus on the customer (C2)	0.045	0.0618	6
A growing market (C3)	0.015	0.0207	21
Clear definition of the target market (C4)	0.022	0.0302	16
Long-term vision (D1)	0.033	0.0454	10
Different levels of cooperation (D2)	0.030	0.0412	12
Entrepreneurial culture in the organization (D3)	0.038	0.0523	8
The time of replacement (D4)	0.020	0.0276	18
Appropriate timing for the project (D5)	0.025	0.0344	14
Product Scores than competitors (E1)	0.028	0.0386	13
Resources to implement the project (E2)	0.054	0.0743	3
product developed Scores than The old type (E3)	0.036	0.0495	9
Generating good ideas by Expert Groups (E4)	0.049	0.0673	5

Data collected from the experts was analyzed with the DEMATEL method. The degree of central role ($D_x + R_x$) in DEMATEL represents the strength of influences both dispatched and received. On the other hand, if ($D_x - R_x$) is positive, then the evaluation criterion x dispatches the influence to other evaluation criteria more than it receives. If ($D_x - R_x$) is negative, the evaluation criterion x receives the influence from other evaluation criteria more than it dispatched. Total relationships matrices are demonstrated in Tables 4 to Table 9.

The results show Management and Staff has great impact on new product development among main aspects.

Table 4. The matrix X (I-X)⁻¹ for Main aspect.

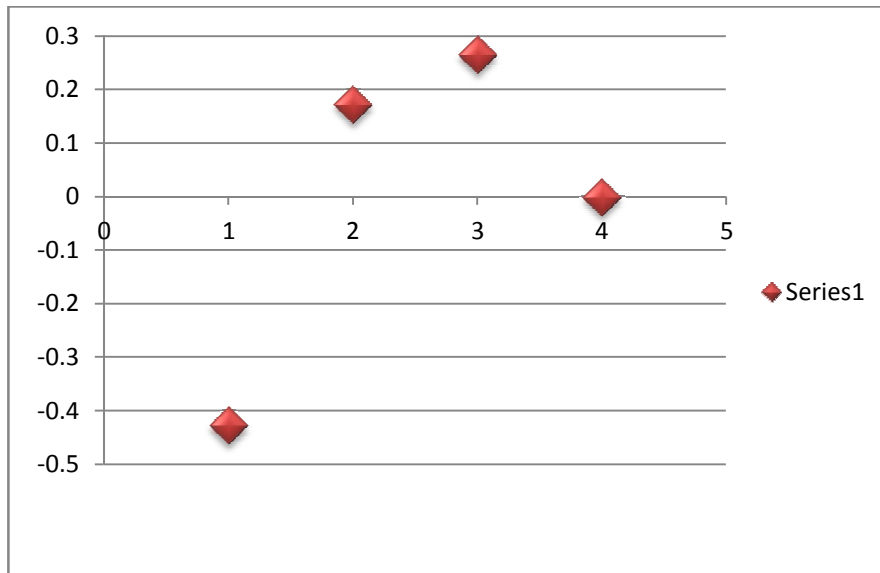
	Management and Staff	Technical factors	Marketing factors	Organizational factors	Commercialization	D	D+R	D-R
Management and Staff	0.247	0.524	0.325	0.451	0.298	1.845	3.52	0.17
Technical factors	0.406	0.269	0.287	0.320	0.365	1.647	3.205	0.089
Marketing factors	0.308	0.243	0.365	0.418	0.513	1.847	3.71	-0.016
Organizational factors	0.439	0.206	0.524	0.257	0.330	1.756	3.449	0.063
Commercialization	0.275	0.316	0.362	0.247	0.340	1.54	3.386	-0.306
R	1.675	1.558	1.863	1.693	1.846			



Among criteria of Management and Staff , Motivation in Product development team members has Great Influence on other criteria.

Table 5. The matrix $X(I-X)^{-1}$ for factor of Management and Staff

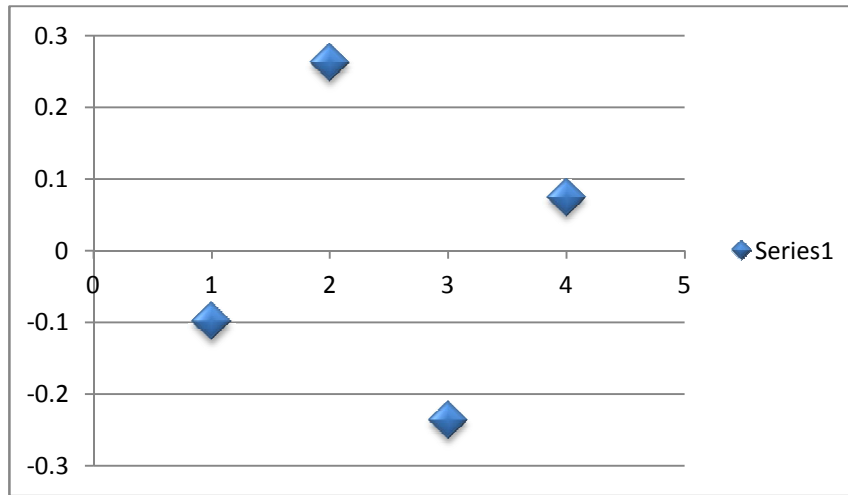
	Senior management commitment	Flexibility and responsiveness to change	Motivation in Product development team members	Risk in decision-making	D	D+R	D-R
Senior management commitment	0.246	0.365	0.285	0.325	1.221	2.872	-0.43
Flexibility and responsiveness to change	0.541	0.298	0.297	0.360	1.496	2.822	0.17
Motivation in Product development team members	0.448	0.305	0.357	0.425	1.535	2.807	0.263
Risk in decision-making	0.416	0.358	0.333	0.327	1.434	2.871	-0.003
R	1.651	1.326	1.272	1.437			



Among criteria of Technical factor , Product Production in Appropriate Time and cost has Great Influence on other criteria.

Table 6. The matrix $X(I-X)^{-1}$ for Technical factor.

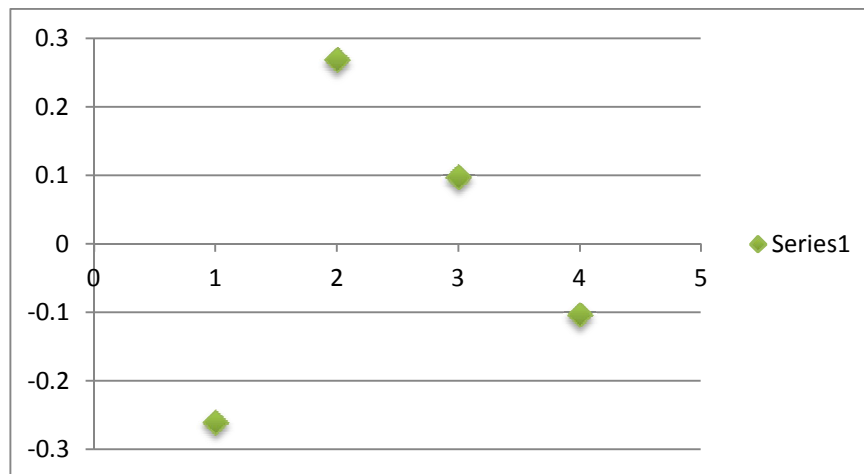
	Technical capabilities	Product Production in Appropriate Time and cost	Clear definition of the functions of the product	Technically difficult to replace	D	D+R	D-R
Technical capabilities	0.251	0.426	0.384	0.358	1.419	2.937	-0.099
Product Production in Appropriate Time and cost	0.517	0.385	0.447	0.416	1.765	3.268	0.262
Clear definition of the functions of the product	0.411	0.338	0.276	0.286	1.311	2.859	-0.237
Technically difficult to replace	0.339	0.354	0.441	0.420	1.554	3.034	0.074
R	1.518	1.503	1.548	1.48			



Among criteria of marketing factor , Focus on the customer has Great Influence on other criteria.

Table 7. The matrix $X(I-X)^{-1}$ for Marketing factor.

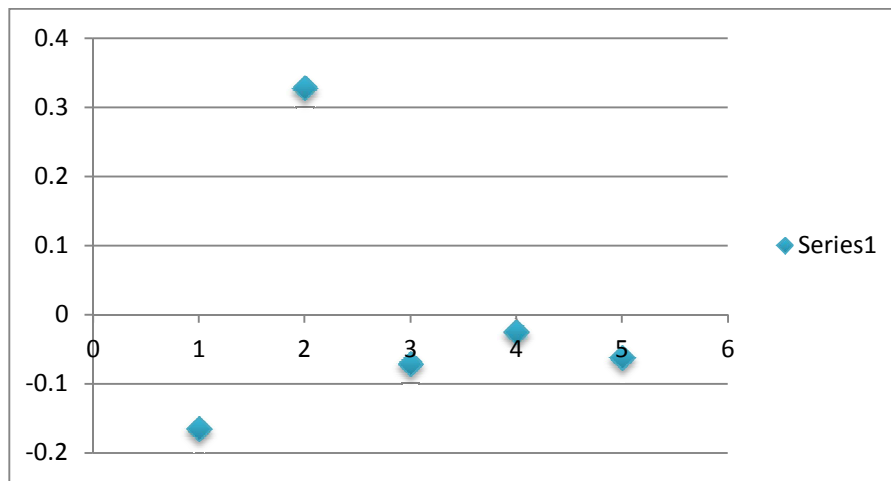
	Appropriate Marketing strategy	Focus on the customer	A growing market	Clear definition of the target market	D	D+R	D-R
Appropriate Marketing strategy	0.425	0.256	0.325	0.307	1.313	2.887	-0.261
Focus on the customer	0.415	0.222	0.259	0.412	1.308	2.348	0.268
A growing market	0.306	0.242	0.325	0.419	1.292	2.487	0.097
Clear definition of the target market	0.428	0.320	0.286	0.337	1.371	2.846	-0.104
R	1.574	1.04	1.195	1.475			



Among criteria of Organizational factor , Different levels of cooperation has Great Influence on other criteria.

Table 8.The matrix $X(I-X)^{-1}$ for Organizational factor.

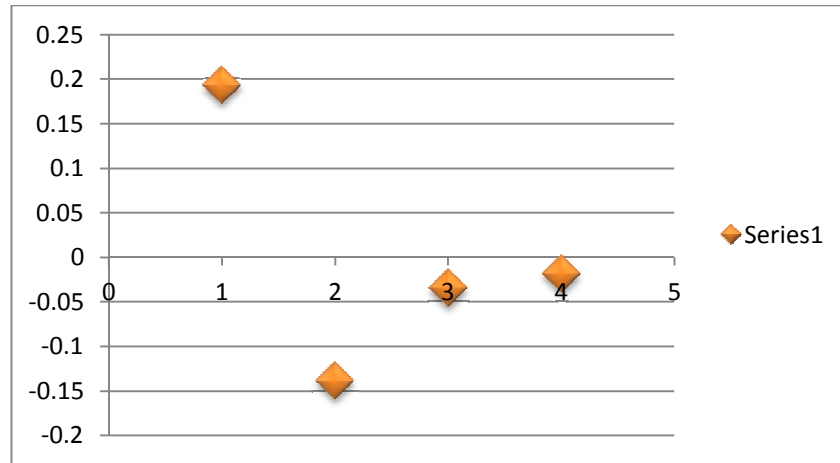
	Long-term vision	Different levels of cooperation	Entrepreneurial culture in the organization	The time of replacement	Appropriate timing for the project	D	D+R	D-R
Long-term vision	0.126	0.236	0.327	0.336	0.514	1.539	3.244	-0.166
Different levels of cooperation	0.426	0.357	0.417	0.367	0.264	1.831	3.335	0.327
Entrepreneurial culture in the organization	0.441	0.327	0.227	0.369	0.418	1.782	3.636	-0.072
The time of replacement	0.349	0.287	0.446	0.329	0.351	1.762	3.55	-0.026
Appropriate timing for the project	0.363	0.297	0.437	0.387	0.340	1.824	3.711	-0.063
R	1.705	1.504	1.854	1.788	1.887			



Among criteria of Commercialization , Product Scores than competitors has Great Influence on other criteria.

Table 9.The matrix $X(I-X)^{-1}$ for factor of Commercialization.

	Product Scores than competitors	Resources to implement the project	product developed Scores than The old type	Generating good ideas by Expert Groups	D	D+R	D-R
Product Scores than competitors	0.125	0.451	0.325	0.452	1.353	2.513	0.193
Resources to implement the project	0.415	0.236	0.225	0.339	1.215	2.569	-0.139
product developed Scores than The old type	0.367	0.259	0.254	0.308	1.188	2.411	-0.035
Generating good ideas by Expert Groups	0.253	0.408	0.419	0.337	1.417	2.853	-0.019
R	1.16	1.354	1.223	1.436			



6. Conclusion

In this study try to Identifying and Prioritization Effective Factors in New product development and the impact of these factors on each Using DEMATEL and ANP Methods. Results of the ANP method shows that Technological factors, Management and Staff factors, Commercialization, factors Organizational factors and Marketing factors are the most important factors in new product development. Results of the DEMATEL method show that Management and Staff have great impact on success of NPD implementation among main aspects. Among criteria of Management and Staff , Motivation in Product development team members has Great Influence on other criteria. Among criteria of Technological factor, Production in Time and cost Appropriate has Great Influence on other criteria.

Among criteria of marketing factor, Focus on the customer has Great Influence on other criteria. Among criteria of Organizational factors , cooperation of Different levels has Great Influence on other criteria. Also, among criteria of Commercialization factor , Product superior to competitors has Great Influence on other criteria.

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10/22/2013