

## Designing a Comprehensive Model for New Product Development in Iran's Home Appliance Industry using Structural Equation Approach

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**Abstract:** The present study aimed to design a comprehensive model for New Product Development (NPD) in Iran's home appliance industry using structural equation approach. In this study, 179 subjects including production managers, design engineers, business managers and sales managers of home appliance companies in Tehran participated. In order to collect data, questionnaire was used. To analyze data resulted from questionnaire, Structural Equation Modeling (SEM) by SmartPLS was used. The results showed significant positive effect of technology on marketing, enterprise integration and market research. Enterprise integration has a significant positive effect on marketing capability and market research but the effect of enterprise integration on product innovation was not significant. Marketing capability had a significant positive effect on product innovation. The effect of market research on product innovation and customer's needs recognition was significant positive. Product innovation had a significant positive effect on product advantage and NPD. Market recognition had a significant positive effect on product innovation and NPD. Also, product advantage had a significant positive effect on NPD.

**Key words:** New product development, home appliance industry, structural equation approach, enterprise integration, marketing capability

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### INTRODUCTION

Now a days, due to progresses in information technology and economic globalization, most of organizations are heavily influenced by competition and global markets. The growth of information technology and increased competition have led to decreased product life cycle, increased rate of product retirement, growth of high quality products and introduction of new products. These factors have encouraged organizations to develop new products considering factors such as decreased products development time, high quality products, decreased costs and better delivery performance in order to maintain profitability and market position (Nazari-Shirkouhi *et al.*, 2013; Frankort, 2016). Moreover, industrial units, due to increased competition in global markets should implement changes in available products or develop new products not only for progress but for their own survival (Chang and Taylor, 2016). New Product Development (NPD) process that is considered a competitive advantage for manufacturing organizations is a multilateral process that includes various aspects such as interaction with innovation networks, collaboration between research and development units and marketing units, existence of efficient supply chains and utilization of knowledge and

expertise of multifunctional teams. Hereunto, this process has never been changed like this (Lynn *et al.*, 2016; Barczak, 2016). A new product can be successful if it can bring more added value for the organization based on three factors of time, cost and quality (Moreno and Aleman, 2016). In fact, the main goal of each organization is to obtain competitive advantage and profitability in long-term period. Therefore, NPD projects are defined with a process-oriented approach in order to convert market opportunities into profit. NPD projects can answer the most fundamental problems of organizations (Hempelmann and Engelen, 2015). On the other hand, dynamics and complexity of concepts associated with NPD, interdisciplinary nature and more competitive organizations as well as emergence of modern equipment and sciences and various services have faced new productions with challenges and forced researchers to utilize different approaches in their studies and obtained efficient results. Although, most of researchers believe NPD is an important factor in economic wealth of a country, unfortunately the importance level of NPD cannot be matched with its success level. Therefore, due to the importance of NPD and its role in economic growth, identification of influential factors seems necessary. Review of previous studies shows that no comprehensive

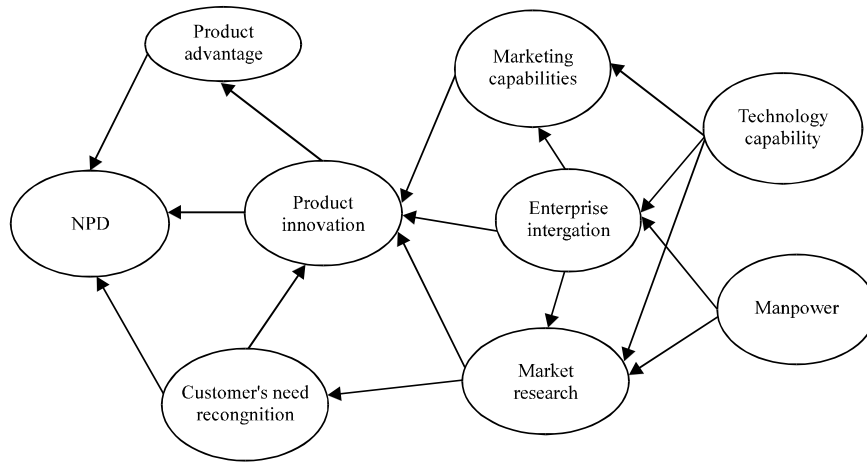


Fig. 1: Conceptual model of the research

study has been conducted to identify factors affecting NPD process in Iran’s home appliance industry. Therefore, the problem is that no comprehensive model exists regarding the development of new products in home appliance and according to the opinions of experts of this industry, it seems that failure rate in NPD in Iran’s home appliance is high. Therefore, according to the importance of factors affecting NPD in home appliance, a comprehensive model has been designed for NPD in this study that will be tested using structural modelling approach by SmartPLS.

**Research hypotheses:**

- Technology capability affects marketing capability
- Technology capability affects enterprise integration
- Technology capability affects market research
- Manpower affects marketing capability
- Manpower affects enterprise integration
- Manpower affects market research
- Enterprise integration affects marketing capability
- Enterprise integration affects market research
- Enterprise integration affects product innovation
- Marketing capabilities affects product innovation
- Market research affects product innovation
- Market research affects customer’s needs
- Customer’s needs recognition affects product innovation
- Customer’s needs recognition affects NPD
- Product innovation affects product advantage
- Product innovation affects product development
- Product innovation affects NPD

**Research conceptual model:** Figure 1 shows research conceptual model. This model includes information technology, manpower, marketing capabilities, enterprise integration, market research, customer’s need recognition,

product advantage, product innovation and NPD. The present study has a more comprehensive look on NPD and aims to investigate the effects of most important variables in technology, organizational factors, product nature and marketing on NPD.

**Theoretical foundations of the study**

**Information technology capability:** Information technology capability points to company’s capability to have a full set of technological sources that provide information to develop information technology applications (Liu *et al.*, 2012).

**Manpower:** Manpower points to competent employments regarding responsibilities and decisions about NPD who have important roles in this context (Chen *et al.*, 2014).

**Marketing capability:** Marketing capability is defined as companie’s capability to achieve better marketing outputs compared to rivals to create more advantages for customers to improve customer satisfaction and to create brand image.

**Enterprise integration:** Enterprise integration points to coordination, suitable internal communication, internal cohesion and sharing knowledge and expertise of different sections to improve NPD (Swann, 2017).

**Market research:** Market research points to studies on market, allocation of sufficient budget, facilities and manpower with knowledge and expertise to recognize customer’s needs.

**Customer’s needs recognition:** Customer’s needs recognition points to company’s efforts to communicate with customers to identify their needs and satisfy expectations through NPD.

**Product advantage:** Product advantage points to the advantages that a certain product provides compared to similar products (Wangbenmad and Rashid, 2014).

**Product innovation:** Product innovation is defined as development or accepting an idea or behavior in business that is new for the organization and creates value from new technology based on new products or processes.

**NPD:** This term is used for products that are new as well as implementation of improvements and changes in available products (Chang and Taylor, 2016).

**Literature review:** Taleiefar and Hataminasab (2011) conducted a study on “services innovation and performance of new products: effects of market capabilities, communication and market turbulence”. They used gap analysis method and classification by TOPSIS technique. The results showed that lack of financial sources for product development project, limitations in production facilities, lack of recognizing customer’s needs, exorbitant costs of development for product development, lack of strategic thinking of senior managements are key factors of lack of success in NPD. Talebi *et al.* (2010) conducted a study on “services innovation and performance of new products: effects of market capabilities, communication and market turbulence”. They used interview and factor analysis. The results showed that market capacity and sensitivity competitive capabilities, marketing and income, product and innovation, financial and management capabilities, inventor’s expertise, technology advantages, costs and profitability are among key factors of NPD success.

Chen *et al.* (2016) conducted a study on “services innovation and performance of new products: effects of market capabilities, communication and market turbulence”. The research method was descriptive and the research design was correlational. The results showed that interactive effects of market capabilities, communication and market turbulence are significant. Salavati conducted a study on improving NPD through risk management. The research method was descriptive and the research design was correlational. The results showed that information risk management, organizational risk management, marketing risk management and commercial risk management influenced NPD performance. Song and Su (2015) conducted a study on “the relationship between quality management and NPD: evidences from China”. The research method was descriptive and the research design was correlational. The results showed that NPD has a significant effect on the relationship between quality management and NPD

performance. Morgan *et al.* (2015) conducted a study on “NPD performance: interaction of entrepreneurial orientation and market orientation”. The research method was descriptive and the research design was correlational. The results showed that entrepreneurial orientation influences novelty of product and performance of NPD. Product novelty degree influenced NPD performance. Market orientation showed mediating role in entrepreneurial orientation of NPD performance. Chang (2017) conducted a study on “increasing NPD performance by adaptation ability and relational learning: mediating role of resources integration”. The research method was descriptive and the research design was correlational. The results showed that adaptation ability and relational learning have a significant effect on resources integration and performance of NPD. Resources integration has a significant effect on NPD performance.

**Sample:** Sample of this study consisted of production managers, design engineers, business managers and sales managers of home appliance companies in Tehran. Since accurate population was not defined, 200 questionnaires were distributed and 184 were returned that 5 cases were excluded from the study due to wrong answers and finally, 179 questionnaires were analyzed.

**Data collection instruments:** To assess model variables, the researcher made questionnaire was used that was based on factors extracted from interviews. Nine valid scale has been used for measuring the variables. The items are measured based on a five-item Likert scale of totally disagree to totally agree. By the data of questionnaire and SPSS software, the reliability coefficient is computed using Cronbach’s alpha.

**Reliability of instruments:** In this study in order to determine the reliability, Cronbach’s alpha was used. This method is used to calculate internal consistency of measurement instrument that measures different constructs. To estimate Cronbach’s alpha coefficient, variance of each sub-question’s score and total variance should be calculated. Then, using the following equation alpha coefficient is calculated:

$$r_{\alpha} = \frac{J}{J-1} \left( 1 - \frac{\sum_{j=1}^n s_j^2}{S^2} \right)$$

Where:

J = The number of sub-questions of questionnaire

$S_j^2$  = Variance of jth sub-test

$S^2$  = Total variance of the questionnaire or test

About acceptable level of Cronbach's alpha, various opinions are presented. In this study, Cronbach's alpha of 0.7 is considered as suitable level for the reliability of instrument. To assess reliability, mixed reliability index is used too.

**MATERIALS AND METHODS**

**Data analysis method:** To analyze data, descriptive and inferential tests were used. In descriptive section, percentage, mean and standard deviation and in inferential section, Pearson correlation tests and SEM will be used based on Partial Least Squares (PLS) method. To analyze data, SPSS and SmartPLS were used.

**Descriptive indices of measured variables:** In this study, descriptive indices of research variables are presented in Table 1.

**Structural model test:** To predict NPD, the proposed conceptual model was examined by SEM and according to research hypotheses, Partial Least Square (PLS) method was used to estimate the model. Research structural model and research hypotheses testing are possible by examining path coefficients (factor loadings) and R<sup>2</sup> values (Abbaszadeh *et al.*, 2012). Also, Bootstrap method (with 500 subsamples) was used to calculate t-statistic values to determine significance of path coefficients. Moreover, Stone-Giesser's Q<sup>2</sup> was used to investigate the predictive capability of dependent variables from used independent variables. Positive values of this coefficient show predictive capability. In

Fig. 2, the tested model of relationship between research variables has been shown. According to this Fig. 2 the effect of technology capability on marketing capability, enterprise integration and market research was significant positive. Manpower showed a significant positive effect on marketing capability, enterprise integration and market studies. Marketing capability had a significant positive effect on product innovation. The effect of market research on product innovation and customer needs recognition was significant positive. Product innovation had a significant positive effect on product advantage and NPD. Market recognition had a significant positive effect on product innovation and NPD. Also, product advantage had a significant positive effect on NPD.

Figure 3 shows t-coefficients of research paths. t-coefficients >±1.96 to ±2.58 are significant at 0.05 and t-coefficients >±2.58 are significant at 0.01. Also, Table 2 presents estimation of path coefficient and explained variance of the research model. According to Table 2, the effect of technology capability on marketing capability, enterprise integration and market research was significant positive. Manpower showed significant positive effect on

Table 1: Descriptive indices of research variables

Variable	Mean	SD
Technology capability	3.49	0.80
Manpower	2.97	0.87
Marketing capability	3.06	0.78
Enterprise integration	2.91	0.90
Market research	2.81	0.79
Customer recognition	2.87	0.84
Product innovation	2.91	1.01
Product advantage	2.65	1.09
NPD	2.89	0.86

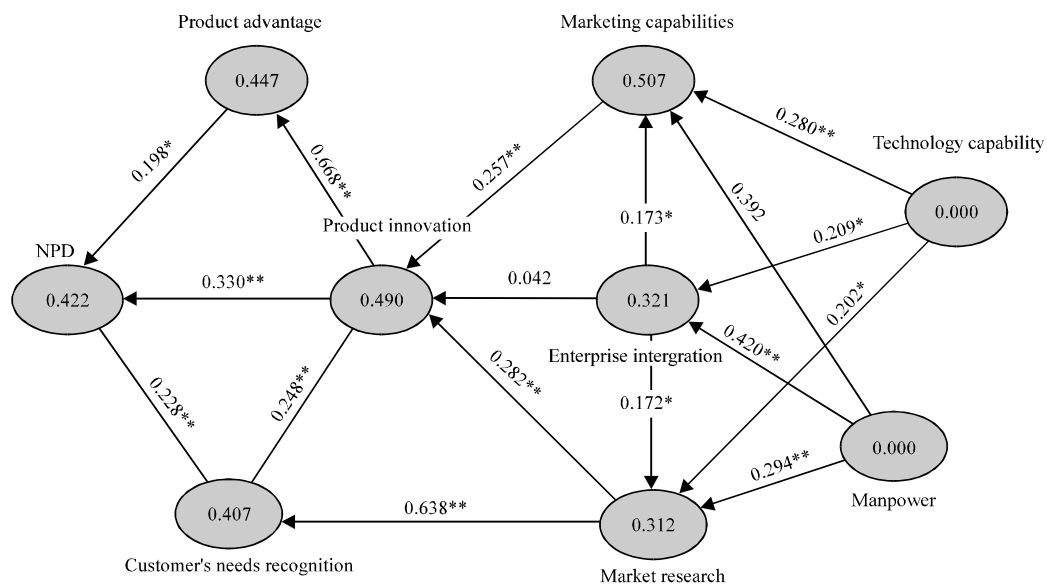


Fig. 2: Tested model of the research; \*, \*\*p<0.05, 0.01

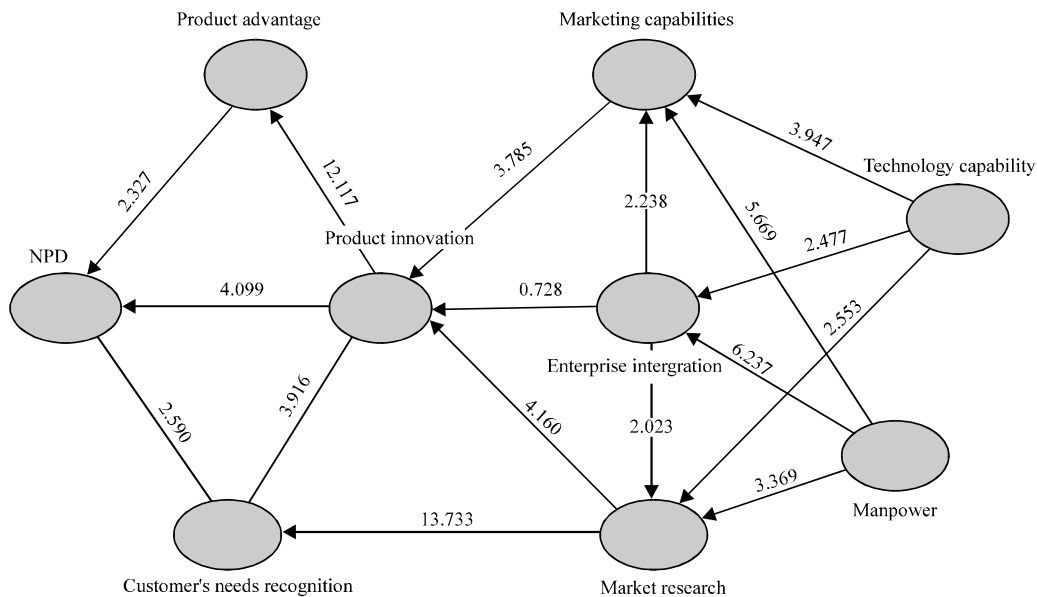


Fig. 3: The t-coefficients of research tested model

Table 2: Path coefficients and explained variance

Variables	Direct coefficients	Explained variance
<b>On NPD from</b>		
Product advantage	0.20*	0.42
Product innovation	0.33**	
customer's need recognition	0.23**	
<b>On product advantage from</b>		
Product innovation	0.67**	0.45
<b>On product innovation from</b>		
Marketing capability	0.26**	0.49
Enterprise integration	0.04	
Market research	0.28**	
Customer's needs recognition	0.25**	
<b>On customer's needs recognition from</b>		
Market research	0.64**	0.41
<b>On market research from</b>		
Enterprise integration	0.17*	0.31
Technology capability	0.20*	
Manpower	0.29**	
<b>On marketing capabilities from</b>		
Enterprise integration	0.17*	0.51
Technology capability	0.28**	
Manpower	0.39**	
<b>On enterprise integration from</b>		
Technology capability	0.21*	0.32
Manpower	0.42**	

\*, \*\*p<0.05, 0.01

Table 3: Commnality credit and redundant variables

Research variables	Q <sup>2</sup> (CV-redundancy)	CV-communality
Technology capability	-	0.553
Manpower	-	0.651
Marketing capability	0.125	0.500
Enterprise integration	0.087	0.602
Market research	0.075	0.534
Customer's need recognition	0.219	0.554
Product innovation	0.174	0.728
Product advantage	0.359	0.806
NPD	0.148	0.574

marketing capability, enterprise integration and market research. The effect of enterprise integration on marketing

capability and market research was significant positive but the effect of enterprise integration on product innovation was not significant. The effect of marketing capability on product innovation was significant positive. The effect of market research on product innovation and customer's needs recognition was significant positive. The effect of product innovation on product advantage and NPD was significant positive. The effect of market recognition in product innovation and NPD was significant positive. The effect of product innovation on NPD was significant positive. Table 3 shows the

Table 4: Results of research hypotheses testing

Hypotheses	Hypothesis confirmation	Hypothesis rejection
Technology capability affects marketing capability	Confirmed	-
Technology capability affects enterprise integration	Confirmed	-
Technology capability affects market research	Confirmed	-
Manpower affects marketing capability	Confirmed	-
Manpower affects enterprise integration	Confirmed	-
Manpower affects market research	Confirmed	-
Enterprise integration affects marketing capability	Confirmed	-
Enterprise integration affects market research capability	Confirmed	-
Enterprise integration affects product innovation	-	Rejected
Marketing capability affects product innovation	Confirmed	-
Market research affects product innovation	Confirmed	-
Market research affects customer's need recognition	Confirmed	-
Customer's need recognition affects product innovation	Confirmed	-
Customer's need recognition affects NPD	Confirmed	-
Product innovation affects product advantage	Confirmed	-
Product innovation affects NPD	Confirmed	-
Product advantage affects NPD	Confirmed	-

communality credit and redundant variables. As the Table 3 shows all communality credit and redundancy values are positive that show suitable quality of the research model.

**Structural model fitness:** To show the validity of research model findings, fitness indices of SEM according to PLS method were used. In the present study for the tested model, GOF index of 0.50 was obtained that shows model's goodness of fit. Three values of 0.01, 0.25 and 0.36 are defined as weak, average and strong values for GOF, respectively (Table 4):

$$GOF = \sqrt{\text{communality} \times R^2}$$

## RESULTS AND DISCUSSION

The results of SEM showed that technology capability has a significant positive effect on marketing capability. Therefore, technology capability leads to improved marketing capability. In explaining this finding, it can be stated that if company has access to modern technologies to develop new products and technology transfer capabilities to develop new products, it can improve marketing capabilities of home appliance companies. The results of SEM showed that technology capability has a significant positive effect on enterprise integration. Therefore, technology capability leads to improved enterprise integration. In explaining this finding, it can be said that technology capability coordinates different sections of the company and helps the company to enjoy from internal cohesion to develop new products where different sections share their knowledge and expertise to develop new products. The results of SEM showed that technology capability has a significant positive effect on market research. Therefore, technology capability leads to

improved market research. In explaining this finding, it can be said that technology capability creates the possibility for companies to use updated technology and knowledge and used new methods in market research to recognize customer's needs. As a result, technology capability leads to improved market research. The results of SEM showed that manpower has a significant positive effect on marketing capability. Therefore, manpower leads to improved marketing capability. In explaining this finding, it can be said that if many competent staff are involved in developing new products, company can use the experiences of manpower to develop new products and increase knowledge and expertise of staff in this regard. These activities lead to improved marketing capability of home appliance companies. The results of SEM showed that manpower has a significant positive effect on enterprise integration. Therefore, manpower leads to improved enterprise integration. In explaining this finding, it can be said that component and experienced manpower increases expertise and knowledge level of the company. The results of SEM showed that manpower has a significant positive effect on market research. Therefore, manpower leads to improved market research. In explaining this finding, it can be said that experienced manpower leads to larger investments on market research context. In other words, competent manpower helps the company to recognize customer's needs. The results of SEM showed that enterprise integration has a significant positive effect on marketing capability. Therefore, enterprise integration leads to improved marketing capability. In explaining this finding, it can be said that if different sections of the company are coordinated to develop new products and share their knowledge and expertise, marketing capability will be improved. The results of SEM showed that enterprise integration has a significant positive effect on market research. Therefore, enterprise integration leads to improved market research.

This finding states that different sections of organization coordinate to improve market research. The results of SEM do not lead to increased product innovation. This finding states that enterprise integration does not have a direct effect on product innovation but indirectly leads to increased product innovation. The results of SEM showed that marketing capability has a significant positive effect on product innovation. Therefore, marketing capability leads to improved product innovation. In explaining this finding, it can be stated that if the company can recognize market and its dynamics, it can understand market condition and improve products quality better than competitors that leads to innovative products. The results of SEM showed that market research has a significant positive effect on product innovation. Therefore, market research leads to improved product innovation. In explaining this finding, it can be said that if the company allocate sufficient budget to plans and provide knowledgeable manpower, innovative products will be produced as the result of studies and recognizing market needs. The results of SEM showed that market research has a significant positive effect on customer's needs recognition. Therefore, market research leads to recognizing customer's needs. This finding states that company can recognize customer's needs through conducting market researches. The results of SEM showed that customer needs recognition has a significant positive effect on product innovation. Therefore, customer's needs recognition leads to product innovation. In explaining this finding, it can be said that if companies have strong communication with customers to recognize their needs, they can produce innovative products based on their needs. The results of SEM showed that customer's needs recognition has a significant and positive effect on product innovation. This finding states that customer's needs recognition by company leads to satisfying customer's needs and improvement in products. The results SEM showed that product innovation has a significant positive effect on product advantage. Therefore, product innovation leads to increased product advantage. This is consistent with the results of a study by Yo. In explaining this finding, it can be said that if the company presents new product and is leading in supplying new products, product advantage increases. The results of SEM showed that product innovation has a significant positive effect on product advantage. Therefore, product innovation leads to increased product advantage.

### **CONCLUSION**

This finding shows that product innovation through supplying new products providing financial sources for

researches and new projects as well as providing new products in new forms affect NPD. The results of SEM showed that product advantage has a significant positive effect on NPD. Therefore, product advantage leads to improved NPD. In explaining this finding, it can be said that any attempt by the company to supply high quality products leads to better and high quality products for the customers that satisfy their needs.

### **SUGGESTIONS**

It is suggested to the managers of home appliance industry to use modern and updated technologies to develop products, increase technology capabilities, improve their capacity to transfer new products and try to have access to superior production technologies. It is suggested to the managers to use their competent staff to be involved in NPD use their experience in developing new products, increase the knowledge of their staff to improve NPD take advantage from technology transfer capabilities to develop new products and have access to superior production technologies. Managers should provide high quality and reliable products with satisfying characteristics.

### **REFERENCES**

- Abbaszadeh, M., J. Amani, H.K. Azar and G. Pashoy, 2012. An Introduction to Structural Equation Modelling Based on PLS and its Application in Behavioral Science. Urmia University, Urmia, Iran.
- Barczak, G., 2016. From the editor special issue: Social networks for innovation and NPD. *J. Prod. Innovation Manage.*, 33: 122-122.
- Chang, C.H., 2017. Enhancing new product development performance from adaptive ability and relationship learning: The mediation role of resource integration. *Total Qual. Manage. Bus. Excellence*, 28: 62-75.
- Chang, W. and S.A. Taylor, 2016. The effectiveness of customer participation in NPD: A meta-analysis. *J. Marketing*, 80: 47-64.
- Chen, C.J., T.C. Liu, M.A. Chu and Y.C. Hsiao, 2014. Intellectual capital and new product development. *J. Eng. Technol. Manage.*, 33: 154-173.
- Chen, K.H., C.H. Wang, S.Z. Huang and G.C. Shen, 2016. Service innovation and new product performance: The influence of market-linking capabilities and market turbulence. *Intl. J. Prod. Econ.*, 172: 54-64.
- Frankort, H.T., 2016. When does knowledge acquisition in R&D alliances increase new product development? The moderating roles of technological relatedness and product-market competition. *Res. Policy*, 45: 291-302.

- Hempelmann, F. and A. Engelen, 2015. Integration of finance with marketing and R&D in new product development: The role of project stage. *J. Prod. Innovation Manage.*, 32: 636-654.
- Liu, Y., L. Wang, C. Yuan and Y. Li, 2012. Information communication, organizational capability and new product development: An empirical study of Chinese firms. *J. Technol. Transfer*, 37: 416-432.
- Lynn, G.S., V. Polat and R.R. Reilly, 2016. Team Trust and Team Learning in New Product Development Projects. In: *Lets Get Engaged! Crossing the Threshold of Marketing's Engagement Era*, Obal, M., N. Krey and C. Bushardt (Eds.). Springer, Cham, Switzerland, pp: 639-640.
- Moreno, M.M. and J.L.M. Aleman, 2016. The differential effect of development speed and launching speed on new product performance: An analysis in SMEs. *J. Small Bus. Manage.*, 54: 750-770.
- Morgan, T., S. Anokhin, A. Kretinin and J. Frishammar, 2015. NPD Performance: The Interplay of Entrepreneurial Orientation and Market Orientation. In: *Ideas in Marketing Finding the New and Polishing the Old*, Kubacki, K., (Ed.). Springer, Cham, Switzerland, pp: 264-267.
- Nazari-Shirkouhi, S., A. Keramati and K. Rezaie, 2013. Improvement of customers satisfaction with new product design using an adaptive neuro-fuzzy inference systems approach. *Neural Comput. Appl.*, 23: 333-343.
- Song, Y. and Q. Su, 2015. The relationship between quality management and new product development: Evidence from China. *Oper. Manage. Res.*, 8: 1-14.
- Swann, W.L., 2017. Modelling the relationship between entrepreneurial orientation, organizational integration and programme performance in local sustainability. *Public Manage. Rev.*, 19: 542-565.
- Talebi, K., M. Salimi and H. Zare, 2010. Identification and prioritization of success factors in developing NPD in small and medium sized businesses in science and technology parks of Tehran. *Mod. Economy Commerce*, 5: 83-100.
- Taleiefar, R. and H.H. Nasab, 2011. Challenges of NPD in small and medium sized enterprises: Case study of selected food and beverage of Fars Province. *J. Parks Growth Centers*, 27: 34-44.
- Wangbenmad, C. and N.R.N.A. Rashid, 2014. Supplier involvement in Product Development Process (PDP) and new product performance: The mediating role of new product advantage. *J. Marketing Manage.*, 2: 227-238.