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Identification and Prioritisation of Supplier, Customer and Organization Collaborating Factors Influencing New Product Development

KEYWORDS: New product development; Supplier collaboration; customer collaboration; Organisational factors; Analytical Hierarchy Process (AHP).

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ABSTRACT *In today's global competitive market, firms are needed to involve supply chain partner and customer to attain the success of a New Product Development (NPD) especially in an Automobile industry. Suppliers and customers may provide a valuable contribution to NPD as they provide access to external knowledge that complements the firm's internal knowledge base. The purpose of this study is to identify and prioritise the suppliercollaboration, customer collaboration and organisational factors which influence the new product development pertaining to automobiles industries. In this study, prioritization mechanism is accomplished by one of the familiar multi criteria decision making methods, Analytic Hierarchy Process (AHP). Based on the results, the supplier, customer and organisation collaborative factors of NPD, such as internal R&D facilities, Organization resources, R&D capability of supplier, Organisational culture of innovation, Technologicalexpertisation of supplier, leadership commitment and customer expertisation have the highest priorities, respectively.*

Introduction

In present days most of the manufacturing companies believe that launching new products on the market is the principal driver of future growth (DelloStritto et al. 2013). The NPD process is one of the most complex tasks within an organization, which embraces the sequence of activities such as product ideation, development, testing and product launch on the marketthat a company performs to conceive, design and sell a product. NPD plays a vital role in the life cycle of any industries. According to Hadia (2009), the factors such as (i) internal or organizational factors, (ii) external or market factors and (iii) product or process factors are influencing the NPD in an organization. In present days, new product development is not a firm internal matter but is increasingly generated in collaboration with external sources. Managing the NPD process has become a challenge for firms as it requires extensive financial, human resources, technological expertisation and is time sensitive. Suppliers and customers may provide a valuable contribution to NPD as they provide access to external knowledge that complements the firm's internal knowledge base (Johnsen, 2009). Despite the extensive research on how to achieve success in NPD, firms continue to deliver products that fail and therefore NPD ranks among the riskiest and most confusing tasks for most companies.This study is focused on to identify and prioritise the supplier, customer and organization collaboration factors which are influencing the NPD.

Research background

In the present global competitive market, NPD is one of the inevitable tasks which is leading to greater product quality. (Dostaler, 2010). The literature on NPD highlights the necessity of introducing new products in the market for continuing business success through employment, economic growth, technological progress, and high standard of living. NPD plays a key role on growth of the companies, which leads to improve profit performance (Ulrich and Eppinger, 2011). Many researchers have studied the impact of various organizational factors on the NPD. For instant, Yapa (2008) has identified organizational strategy, structure, culture and leadership as noteworthy internal factors influencing the NPD process in the banking industry. According to Hadia (2009), strategic factors such as learning organizational perspective, organization culture of innovation, inter functional coordination and communication, top management support and commitment are responsible for the successful NPD.

Supplier collaboration in NPD

Suppliers play a vital role in enabling companies to rise to the demanding challenges of NPD. Strategic supplier considerations should be built into improvement initiatives for product inception, product development and product launch. There is a need to synchronize the supply chain partners' approaches for understanding the product architecture, discovering, accelerating product development and mutually protecting their intellectual property. Strategic supplier considerations need to be built into NPD initiatives in the important areas such as product inception, product development and product launch. Wagner and Hoegl (2006) argued that supplier involvement in NPD will increase in industries other than the automotive industry. The reasons for the involving supplier in NPD are reduction of R&D resources at the firm, to acquire supplier's knowledge, and to achieve a shorter time to market and a lower cost for the NPD.

Customer collaboration factors in NPD

Customer involvement is another important factor for the

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success of NPD process which results better firm performance and higher customer satisfaction (Tan and Tracey, 2007; Gruner and Homburg, 2000; Johnson and Filippini, 2009). Rauniar et al. (2008) found that glitches in product design and time taken for NPD were reduced by the customer involvement in an US based automotive industry. Chien and Chen (2010) studied the factors influencing NPD in financial services firms of Taiwan and found that the customer involvement had significant effect on NPD success. According to Renko et al. (2009), close partnership with customers during NPD will improve the quality of innovation and provide access to resources that the focal firm lacks in-house.

Organisational factors

Studies have also proved that the top management also plays a vital role in the NPD (Edgar et al. 2009). Many research studies found that an organization's culture and its resources also influencing the decisions related to NPD (Yapa, 2008; Hadia, 2009; Hepperle et al. 2010).

Several studies have found that supply chain partner and customers collaboration have positive relationship with NPD and innovativeness. Previous studies either investigate supplier involvement (SI) or customer involvement (CI) in NPD process, but ignore the simultaneous impact of SI and CI. There is only one study investigated both SI and CI about NPD in financial industry (Chien and Chen, 2010). Sun et al. (2010), investigated the impact of both SI and CI on the New Product Performance. Hence, there is a lack of studies that investigate the impact of collaborative factors from multi perspectives such as supplier, customer and organisation on NPD.

Analytic Hierarchy Process (AHP) in NPD

The Analytic Hierarchy Process (AHP) analysis, proposed by Thomas L. Saaty in 1980, is a pair-wise comparison methodology used to rank the alternatives on absolute scales by taking into account the importance of the different criteria (Saaty and Vargas, 2000; Tuzmen and Sipahi, 2011). Many studies have highlighted the prominence of the AHP in NPD process. Pun et al. (2010) developed self-assessment model for the assessment of NPD performance using AHP. Battistoni et al. (2013) defined the weights of customer needs connected to the NPD process of a typical food industry. Salgado et al. (2012), applied AHP to prioritise the activities of NPD for electronic products manufacturing companies. Salomon et al. (2011), prioiritsed the NPD projects by using AHP in an automotive industry. Gurumurthy and Kodali (2012), used AHP for the selection of a methodology to improve the product development process. Based on the literature review**,** the present work, probably the first of its kind of work focuses on developing the AHP hierarchy model to prioritise the supplier, customer and organisation collaborative factors which play major role in the success of NPD.

Research methodology

Construction of AHP hierarchy model

In this study, the first level of the proposed AHP hierarchical model as shown in figure 1, encompasses the organization's goal (Prioritisation of collaborative factors of supply chain partner, customer and organization for new product development). Second level components are the three dimensions such as supply chain partner, customer and organization which are associated with NPD process (Supplier collaboration factors, Customer collaboration factors and Organisational factors) and each component is grouped in to specific indicators of third level. The third level indicators are derived from the review of literature and conducting focus group interviews with the representatives of management, supply chain partner and customer ofthe companyand are presented in Table 1.

Once the list of criteria is derived, AHP hierarchy model shown in figure 1. is then developed to determine the relative importance of these criteria and to prioritise the criteria.

Table 1. Supplier, customer and organisation collaborative factors and propositions

Factors	Propositions
Supplier Collaboration	
Trust and Transparency	Trust and transparency in the activities of collaborating partner and is viewed as a willingness to forego opportunistic behavior (Muhwezi, 2010).
Technological Expertise	Suppliers' expertisationin the development of a new product Nassimbeni & Battain (2003).
R&D capability	Capability of Suppliers to carry out the R&D activitiesregarding the development of new product.
Size and stability of the supplier	Size and stability of the supplier is an essential factor for new product development.
Support in research and decision making	Ability of the supplier to propose innovative solutions in decision making and support in conducting research during the new product development.
Support in the product launch	Supplier's involvement and support in product launch management
Sharing knowledge and information	Willingness of supplier to shareknowledge and information
Efforts to make product and process compatible	Effort of the supplier to make the characteristics of the product and his own productive processes compatible with shorter lead times and cost control. Nassimbeni & Battain (2003).
Promptness and reliability in prototyping	Timely response and reliability of supplier in making the prototype models. Nassimbeni & Battain (2003).
Customer Collaboration	
Customer expertisation	Customer expertisation can lead to success of product innovation (Gudda et al. 2013).
Familiarity with new product	Familiarity of customers with technology and characteristics of new product
Customer Proximity	Customer proximity may lead to an advantage in terms of product innovation based on customer needs and wants (Tsai, 2009).
Participation in decision making	Effective participation of customer in decision making with regarding to NPD.
Customers' reputation in the market	Reputation of OEM in the market.
Organisational factors	
Organisational culture of innovation	Firm's ability to cultivate innovation culture. Sumrit, & Anuntavoranich (2013)
Organization resources	Firm's ability to acquire and allocate appropriate capital & technology resources for new product development. Sumrit & Anuntavoranich, (2013)
Internal R & D facilities	Firm's ability to perform R & D activities in the firm itself.
Leadership commitment	Commitment of firm's Top level management in NPD (Edgar, Dunn and Co., 2009).

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Inter functional coordination and communication	Internal coordination and communication enhances collaboration of different functions of organization, which in turn favor problem solving and better product development performance. (Sosa and Mihm, 2008)

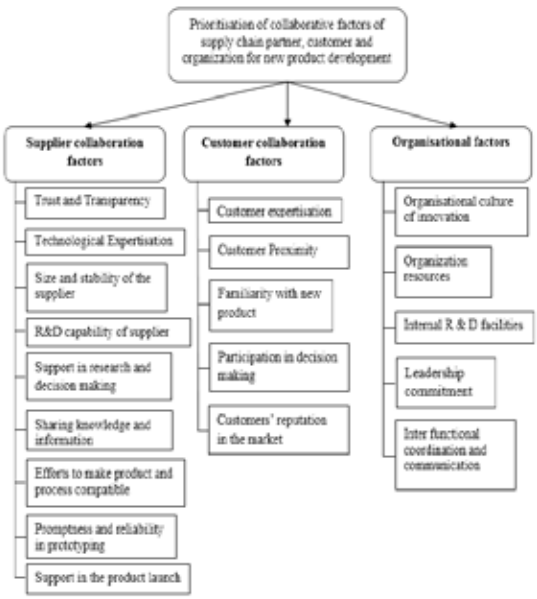

Fig. 1

Proposed AHP hierarchy model

After the hierarchy model has been established, the criteria must be evaluated in pairs so as to determine the relative importance between them and their relative weight. The prioritization mechanism is accomplished by assigning a number from a semantic scale developed by Saaty (1980) to represent the relative importance of the criteria. Pairwise comparisons matrices of these factors provide the means for calculation of importance (Sharma et al., 2008). For that purpose a questionnaire must be built, for all of the possible pair-wise comparisons among the factors. The scale of importance must be set up prior to the questionnaire in order to enable correct evaluation of the criteria. In this study, the Satty's semantic scale of 1 to 9 is adopted as shown in Table 2.

Table 2 – Saaty's AHP semantic scale (adopted from Satty, 2005)

Scale	Numerical Rating	Reciprocal
Extremely Preferred	9	1/9
Very strong to extremely	8	1/8
Very strongly preferred	7	1/7
Strongly to very strongly	6	1/6
Strongly preferred	5	1/5
Moderately to strongly	4	1/4
Moderately preferred	3	1/3
Equally to moderately	2	1/2
Equally preferred	1	1

The elements in the next hierarchical level are arranged in theform of a matrix and pairwise judgmental values are assigned in satisfying the decision element if the present level for which the comparison matrix is built. Similarly, elements in the next level down are subjected to pairwise comparisons for a particular decision element in previouslevel and values are assigned.

The pairwise comparison values produce a ratio scale of weights of the relative importance. The observed pairwise relative weights matrix contains inconsistencies. Saaty (1980) proposed the consistency index (CI) and consistency ratio (CR) equations (1) and (2) to verify the consistency of pairwise comparison matrix.

$$CI = \lambda_{max} - n / (n-1) \quad (1)$$

Where λ_{max} = maximum eigenvalue of the matrix of the importance ratios and n= number of factors.

$$CR = CI / RI \quad (2)$$

where the Random Index (RI) is given by Table 3 (Saaty, 1980). If the value of the consistency ratio (CR) is lessthan or equal to 0.1, the estimation is considered acceptable.

Table 3: Random Index Table

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The overall priorities were determined by multiplying the priority vectors of the criteria by the priorities for each alternative decision for each objective.

Case analysis

In this study, the case company under consideration is one of the leading Tier 1 automotive products manufacturing firm located in South India, which supplies various types of automotive products and services to original equipment manufacturers (OEM). All pairwise comparisons in the application are performed by the team of experts. A group of expert team comprising representatives from various departments of the case company and OEM were requested to do the several pairwise comparisons. The result of the survey questionnaire technique was then used as input for the AHP.

Results and discussion

The matrices of pairwise comparisons and normalizations of the criteria are presented in the Tables 4-11.

Table 4. Pair wise comparison of supplier, customer and organization collaborative factors

	SC	CC	OF
Supplier Collaboration factors (SC)	1	2	1/2
Customer Collaboration factors (CC)	1/2	1	1/2
Organisational factors (OF)	2	2	1

Table 5. Normalised Matrix

	SC	CC	OF	Relative Weight	λ max
Supplier Collaboration factors (SC)	0.286	0.400	0.250	0.312	0.952
Customer Collaboration factors (CC)	0.143	0.200	0.250	0.198	0.599

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Organisational factors (OF)	0.571	0.400	0.500	0.490	1.510
CR* = 0.05					

Note: *CR – Consistency ratio

Table 6. Pairwise comparison of supplier collaboration factors

	TT	TE	SSS	RD	SRDM	SKI	EPPC	PRP	SPL
Trust and Transparency (TT)	1	1/2	2	1/5	1/2	1/3	1/3	1/4	1/3
Technological Expertisation (TE)	2	1	2	1/4	2	3	2	2	2
Size and stability of the supplier (SSS)	1/2	1/2	1	1/4	2	2	1/2	1/2	2
R&D capability of supplier (RD)	5	4	4	1	6	5	4	4	5
Support in research and decision making (SRDM)	2	1/2	1/2	1/6	1	2	3	1/3	2
Sharing knowledge and information (SKI)	3	1/3	1/2	1/5	1/2	1	1/2	1/2	2
Efforts to make product and process compatible (EPPC)	3	1/2	2	1/4	1/3	2	1	2	3
Promptness and reliability in prototyping (PRP)	4	1/2	2	1/4	3	2	1/2	1	3
Support in the product launch (SPL)	3	1/2	1/2	1/5	1/2	1/2	1/3	1/3	1

Table 7. Normalised Matrix of supplier collaboration factors

	TT	TE	SSS	RD	SRDM	SKI	EPPC	PRP	SPL	Relative Weight	λ max
Trust and Transparency (TT)	0.04	0.06	0.14	0.07	0.03	0.02	0.03	0.02	0.02	0.085	0.471
Technological Expertisation (TE)	0.09	0.12	0.14	0.09	0.13	0.17	0.16	0.18	0.10	0.352	1.361
Size and stability of the supplier (SSS)	0.02	0.06	0.07	0.09	0.13	0.11	0.04	0.05	0.10	0.130	0.755
R&D capability of supplier (RD)	0.21	0.48	0.28	0.36	0.38	0.28	0.33	0.37	0.25	1.030	3.359
Support in research and decision making (SRDM)	0.09	0.06	0.03	0.06	0.06	0.11	0.25	0.03	0.10	0.120	0.923
Sharing knowledge and information (SKI)	0.13	0.04	0.03	0.07	0.03	0.06	0.04	0.05	0.10	0.110	0.607
Efforts to make product and process compatible (EPPC)	0.13	0.06	0.14	0.09	0.02	0.11	0.08	0.18	0.15	0.112	1.080
Promptness and reliability in prototyping (PRP)	0.17	0.06	0.14	0.09	0.19	0.11	0.04	0.09	0.15	0.083	1.193
Support in the product launch (SPL)	0.13	0.06	0.03	0.07	0.03	0.03	0.03	0.03	0.05	0.060	0.510
CR = 0.10											

Table 8. Pairwise comparison of customer collaboration factors

	CE	CP	FP	PDM	CRM
Customer expertisation (CE)	1	2	2	3	3
Customer Proximity (CP)	1/2	1	1/2	1/2	1/2
Familiarity with new product (FP)	1/2	2	1	2	2
Participation in decision making (PDM)	1/3	2	1/2	1	2
Customers' reputation in the market (CRM)	1/3	2	1/2	1/2	1

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Table 9. Normalised Matrix of customer collaboration factors

	CE	CP	FP	PDM	CRM	Relative Weight	λ max
Customer expertisation (CE)	0.375	0.222	0.444	0.429	0.353	0.365	1.932
Customer Proximity (CP)	0.188	0.111	0.111	0.071	0.059	0.081	0.554
Familiarity with new product (FP)	0.188	0.222	0.222	0.286	0.235	0.111	1.222
Participation in decision making (PDM)	0.125	0.222	0.111	0.143	0.235	0.108	0.879
Customers' reputation in the market (CRM)	0.125	0.222	0.111	0.071	0.118	0.075	0.666
CR = 0.05							

Table 10. Pairwise comparison of organisational factors

	OCI	OR	IRD	LC	ICC
Organisational culture of innovation (OCI)	1	1/3	1/3	2	1/2
Organization resources (OR)	3	1	1/3	2	2
Internal R & D facilities (IRD)	3	3	1	4	3
Leadership commitment (LC)	1/2	1/2	1/4	1	2
Inter functional coordination and communication (ICC)	2	1/2	1/3	1/2	1

Table 11. Normalised Matrix of organisational factors

	OCI	OR	IRD	LC	ICC	Relative Weight	λ max
Organisational culture of innovation (OCI)	0.105	0.062	0.148	0.211	0.059	0.642	0.117
Organization resources (OR)	0.316	0.188	0.148	0.211	0.235	1.198	0.219
Internal R & D facilities (IRD)	0.316	0.563	0.445	0.421	0.353	2.281	0.419
Leadership commitment (LC)	0.053	0.094	0.111	0.105	0.235	0.210	0.120
Inter functional coordination and communication (ICC)	0.211	0.094	0.148	0.053	0.118	0.140	0.125
CR = 0.08							

The overall priority scores obtained from the pairwise comparisons and normalized matrices are depicted in Table 12.

Table 12. Overall priority scores of supplier, customer and organization collaborative factors

Dimensions	Group Priority	Criteria	Factor Priority	Overall Priority
Supplier collaboration factors	0.312	Trust and Transparency (TT)	0.085	0.027
		Technological Expertisation (TE)	0.352	0.110
		Size and stability of the supplier (SSS)	0.130	0.041
		R&D capability of supplier (RD)	1.030	0.321
		Support in research and decision making (SRDM)	0.120	0.037
		Sharing knowledge and information (SKI)	0.110	0.034
		Efforts to make product and process compatible (EPPC)	0.112	0.034
		Promptness and reliability in prototyping (PRP)	0.083	0.026
		Support in the product launch (SPL)	0.060	0.019
Customer collaboration factors	0.198	Customer expertisation (CE)	0.365	0.072
		Customer Proximity (CP)	0.081	0.016
		Familiarity with new product (FP)	0.111	0.022
		Participation in decision making (PDM)	0.108	0.021
		Customers' reputation in the market (CRM)	0.075	0.015
Organisational factors	0.490	Organisational culture of innovation (OCI)	0.642	0.315
		Organization resources (OR)	1.198	0.587
		Internal R & D facilities (IRD)	2.281	1.118
		Leadership commitment (LC)	0.210	0.103
		Inter functional coordination and communication (ICC)	0.140	0.069

The results of the AHP weighting strategy suggest that organization factors (0.490) and supplier collaboration factors (0.312) are ranked first and second respectively in the group priority according to the new product development followed by customer collaborations factors (0.198) as the third one. This indicates that by promoting the internal organization and supplier collaboration factors, organisation can be achieved effective NPD. The results also showed that the factors namely, Internal R & D facilities (1.118), Organization resources (0.587), R & D capability of supplier (0.321), Organisational culture of innovation (0.315), Technological Expertisation (0.110), Leadership commitment (0.103) and Customer expertisation (0.072) are the most important ones with topmost priority in overall scores and it is better that the case company may focus on these factors to improve the performance of NPD.

Conclusion

In the present research work, the attempts were made for identifying and prioritizing the supplier, customer and organizational collaborative factors which play major role in success of NPD. In this study the AHP hierarchy model was successfully developed for prioritizing the supplier, customer and organizational collaborative factors and validated by the case organization involved in the manufacturing of

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automotive products. According to the results of AHP analysis, among the relevant factors in supplier collaboration, the most important factor was "R&D capability of supplier", followed by "Technological Expertisation" of supplier, "Size and stability of the supplier" and "Support in research and decision making". Similarly, among the various customer collaboration factors, "Customer expertisation" was given first priority. On the other hand, "Internal R & D facilities" was ranked first followed by "Organization resources", "Organisational culture of innovation" and "Leadership commitment" in internal organisational factors. Furthermore, "Internal R & D facilities", "Organization resources" and "R&D capability of supplier" ranked first, second and third respectively in overall priority. This indicates that for the successful of NPD, the organisation may focus on the above mentioned three factors.

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