



Analysis of new product development research: 1998-2009

Analysis of
NPD research

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Abstract

Purpose – The purpose of this paper is to present a systematic review and analysis of existing research articles on new product development (NPD) published in the 12-year period starting from 1998 to 2009.

Design/methodology/approach – To explore the articles related to NPD, four key words namely new product, product design, product development and product innovation were used in combination of title or abstract or keyword of the articles through several knowledge databases. The abstracts of journal papers were read and a decision as to whether article belongs to any NPD research issue or not was made. In total, 1,127 research articles were categorized systematically and then analyzed on various principal NPD information groups.

Findings – Analysis of selected articles led to a certain level of dispersion in the publication of NPD research in different journals. It is found that more attention needs to be on knowledge and creativity management, communication and information transfer in any NPD process.

Originality/value – By observing extended literature from authors reviewing articles from various journals, growth in research, and variety of topics covered in NPD, a broad systematic multi journal review of NPD literature is clearly overdue. The authors have developed a comprehensive listing of publications on NPD where they have classified the surveyed papers according to various principal NPD information groups like: published year, NPD research stream, type of organization studied (industrial/consumer/service), level of innovation (high/moderate/low), NPD focus on frameworks, performance perspective (success, failure or both), NPD research design (conceptual/empirical and qualitative/quantitative) and NPD relevant best practice element. Based on the classification scheme, the issues were analyzed from the system's perspective and their implications to NPD research.

Keywords Innovation, Product design

Paper type Literature review

1. Introduction

The product development process objective is to transform the market opportunity and a set of assumptions about product technology into a product available for sale (Krishnan and Ulrich, 2001). New product development (NPD) is recognized as one of the most critical areas of firm's competence related to business success (Guo, 2008). Product Development and Management Association (PDMA) best practices surveys (Page, 1993; Barczak *et al.*, 2009) concluded that, although firms had implemented a number of

Due to space constraint, only quantitative analysis is reported in this article. Reader interested in a particular research issue who wish to identify the articles dealing with specific research issue, can contact the first author at: kalluri.vinayak@gmail.com



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new methods and techniques to improve the way new products were developed, new product success rates continue to be remain stable at around 60 percent. The possibility of improving the new product success rate is always a key motivation in conducting research in NPD by developing the new practices. The total number of NPD review articles available in literature is very less. Page and Schirr (2008) have emphasized the need and importance of a systematic multi journal literature review on NPD research.

Therefore, the objective of this paper is to present a systematic review and analysis of existing literature on NPD. The concerned articles were identified through a number of databases published between 1998 and 2009. The articles were then classified and arranged into the principal NPD information groups so as to permit the visualization of all the information of interest. Section 2 critically examines various past literature reviews related to NPD. Section 3 elaborates the methodology adopted to perform a comprehensive and critical analysis of literature review of NPD and also reports the analysis results on various principal NPD information groups. This is followed by discussion on present research, significant findings, gaps that were identified and future direction in Section 4 and the conclusions in Section 5.

2. Literature reviews related to NPD

Table I summarizes the different reviews in the field of NPD in chronological order.

It is evident from Table I that majority of the literature reviewed had a focus on reviewing a particular issue in NPD like new product performance (Montoya and Calantone, 1994; Henard and Szymanski, 2001; Pattikawa *et al.*, 2006), success factors (Poolton and Barclay, 1998; Ernst, 2002), product positioning and design (Kaul and Rao, 1995), and NPD speed (Chen *et al.*, 2010). Additionally reviews by certain authors can be found addressing issues in product design such as engineering change management (Wright, 1997), decisions in product development (Krishnan and Ulrich, 2001), management practices in product innovation (Guo, 2008) and Innovation typology and innovativeness terminology (Garcia and Calantone, 2002). Literature reviews on NPD performance (Montoya and Calantone, 1994; Henard and Szymanski, 2001) were focused on meta-analyses of new product performance determinants. These meta-analyses summarized results of 18 and 60 empirical studies, respectively. Both the articles compared the constructs used, tested the contribution of common variables to success, pointed out limitations in the research methods, and suggested future directions for research. Montoya and Calantone (1994) concluded that new product performance literature content, research methodology, data set characteristics and variable operations are highly diverse and research on new product performance is not highly consistent in terms of which factors are to be included in each study and which statistics are to be reported. On the other hand, Henard and Szymanski (2001) discussed about significant and non significant drivers of performance, dominant drivers of performance, breadth of performance drivers and prior emphasis in performance modeling and concluded that giving more emphasis on market place, strategy, and product characteristics than process characteristics is more appropriate for augmenting success levels. Pattikawa *et al.* (2006) reviewed new product performance research at the project level by investigating the variables associated with new product project performance. This review was extended to formulate the central tendency and variance in the composition of the variables associated in the form of a correlation coefficient and stated that new product project performance is highly depended on strong market orientation, proficiency in NPD, synergy of resources

S. no.	Authors	Year	Review period	Reviewed journals ^a	No. of articles reviewed	Area of research
1	Montoya and Calantone	1994	N/A	N/A	18	New product performance
2	Kaul and Rao	1995	N/A	N/A	28	Product positioning and design
3	Wright	1997	1980-1995	N/A	23	Engineering change management implications in product design
4	Poolton and Barclay	1998	N/A	N/A	N/A	NPD success factors
5	Henard and Szymanski	2001	N/A	N/A	60	New product performance
6	Krishnan and Ulrich	2001	1988-1998	<i>MS, MAS, JMR, RP, SM, EM, JPIM, RED, JMD</i>	200	NPD decisions in the fields of marketing, operations management, and engineering design
7	Ernst	2002	N/A	N/A	30	Success factors of NPD from empirical studies
8	Garcia and Calantone	2002	Through 1979	N/A	21	NPD innovation typology and innovativeness terminology
9	Biemans	2003	Previous 25 years	N/A	N/A	NPD research methodological issues
10	Pattikawa <i>et al.</i>	2006	Through 1996	N/A	47	New product project performance
11	Guo	2008	1984-2005	<i>JPIM</i>	544	Management practices in product innovation
12	Page and Schirr	2008	1989-2004	<i>JPIM, JM, JMR, IMM, ASQ, AMR, SMJ, AMJ, R&DM, R/TM</i>	815	NPD
13	Chen <i>et al.</i>	2010	N/A	N/A	70	NPD speed

Notes: ^a*AMJ* – *Academy of Management Journal*; *AMR* – *Academy of Management Review*; *ASQ* – *Administrative Science Quarterly*; *EM* – *Engineering Management*; *IMM* – *Industrial Marketing Management*; *JM* – *The Journal of Marketing*; *JMD* – *Journal of Mechanical Design*; *JMR* – *Journal of Marketing Research*; *JPIM* – *The Journal of Product Innovation Management*; *MAS* – *Marketing Science*; *MS* – *Management Science*; *R&DM* – *R&D Management*; *R/TM* – *Research Technology Management*; *RED* – *Research in Engineering Design*; *RP* – *Research Policy*; *SM* – *Strategic Management Journal*; *SMJ* – *Strategic Management Journal*

Table I.
Literature reviews on
NPD research

and strong inter-functional coordination. Two literature reviews (Poolton and Barclay, 1998; Ernst, 2002) can also be found focusing on the identification of the success factors in new product performance. These two reviews summarized the success factors from the past literature and pointed out the limitations in applying these success factors to develop successful products in the market.

Kaul and Rao (1995) reviewed recent research in marketing on product positioning and product design and proposed a framework to integrate them into a single decision.

Their review suggested that a firm should optimize its goals with respect to product attributes and then translate these attributes into product characteristics and levels of marketing mix variables. Chen *et al.* (2010) focused on reviewing 70 empirical articles related to NPD speed. Their review identified 17 most frequently examined antecedents of NPD speed and further stated that these antecedents are organized into four groups of characteristics namely; strategy, project, process, and team to explore the relationships between NPD speed and its 17 commonly studied antecedents. Krishnan and Ulrich (2001) focused on the fundamental decisions that are made by intention or default in product development projects within a single firm which develops physical goods. In contrast with other reviews, the decision-making literature reviewed by the authors focus on the importance of environmental and contextual variables, such as market growth rate, the competitive environment, or the level of top-management support and identified about 30 major decisions that are made within product development organizations.

A review of literature from the marketing, engineering and NPD disciplines were conducted by Garcia and Calantone (2002) to define the innovation typology and innovativeness terminology in NPD literature and stated that it is important to consider both marketing and technological perspective as well as macro level and micro level perspective when identifying innovation. A classification scheme was also proposed to classify innovations in NPD and suggested future directions for research.

Among the list of reviews shown in Table I, the sample size of literature review is another issue. It is evident from Table I that only two comprehensive literature reviews could be identified that considered over 500 articles in their proposed study. The review by Guo (2008) involved 544 articles published only in *Journal of Product Innovation Management (JPIM)* spread over a span of 22 years. But since it is biased towards only one journal, it cannot be considered for tracing the direction of growth of NPD research. Another comprehensive review by Page and Schirr (2008) also reviewed 815 articles on NPD literature covering a period of 16 years which mainly focused on ten selected journals. This review mainly focused on growth in NPD research, an examination of the level of analysis, analysis of trends in research design and analytical techniques, details of the data sets used in empirical studies, a study of knowledge domains used to study NPD in the articles identified from selected journals. By observing such extended literature, growth in research, and variety of topics covered in NPD, a broad systematic multi journal review of NPD literature is clearly overdue (Page and Schirr, 2008).

This literature review has broadly six main objectives:

- (1) to describe the growth of research and the research streams in NPD research during the 12 years from 1998 to 2009;
- (2) to classify the domains of knowledge and methods employed in research and show the changes and trends over the time period;
- (3) to identify the focus of innovation, framework development and performance measurement in NPD research;
- (4) to explore different research methodology, i.e. conceptual or empirical in NPD;
- (5) to list and classify the NPD best practices elements; and
- (6) to suggest future directions in NPD research.

3. Methodology and analysis

3.1 Journal and article selection

The present article begins with an explanation of time horizon and the journal selection for review used in the study. Research articles published in the 12-year period starting from 1998 to 2009 were selected for the present review. For systematic review of the literature on NPD, the criterion proposed by Gosling and Naim (2009) was used for including papers in the review, i.e. candidates for inclusion which includes published journal articles not limited to particular journals. Even though some reviews focused on selected journals (Page and Schirr, 2008; Krishnan and Ulrich, 2001; Guo, 2008), it is clear from the literature review that most reviewers were not following any criteria in selection of the journal. To explore the articles related to NPD, four key words namely new product, product design, product development and product innovation were used in combination of title or abstract or keyword of the articles through several databases including internet searches, Google Scholar, Scopus, Science Direct and Emerald, etc. The abstracts of journal papers were read and a decision as to whether article belongs to any NPD research issue or not were made. Further, we also reviewed all appropriate references of the related studies. In total 1,127 research articles (see the Appendix) were identified as relevant to the present study from the databases and search engines along with cross reference of the articles. Information on eight different principal NPD information groups were coded for each article:

- (1) published year;
- (2) NPD research stream;
- (3) type of organization studied (industrial/consumer/service);
- (4) level of innovation (high/moderate/low);
- (5) NPD focus on frameworks;
- (6) performance perspective (success, failure or both);
- (7) NPD research design (conceptual/empirical and qualitative/quantitative); and
- (8) NPD relevant best practice element.

3.2 Growth in articles

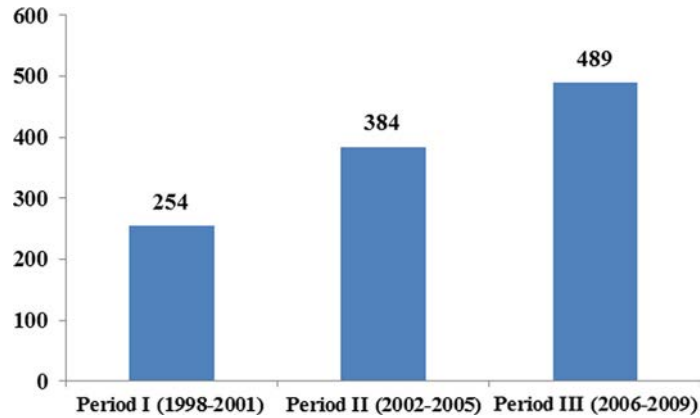
To view the growth over time, the review span (12 years) was divided into three periods, each representing four years (1998-2001, 2002-2005 and 2006-2009). The authors felt that, this is a reasonable length of time to study the changes and therefore the same scheme is continued in the entire article to represent the trends, wherever required. Figure 1 shows the constant growth of NPD publications from periods I (1998-2001) to III (2006-2009).

It is observed that the growth rate is around 100 percent from periods I to III, which shows that focus on NPD research is increasing at a good speed.

3.3 Growth in the NPD research stream

NPD research stream classification proposed by Guo (2008) was adopted to verify the growth of NPD research streams. As suggested by Guo (2008), all 1,127 articles were classified into the six research areas and these six areas were subdivided into 26 topics. Although many studies could legitimately be viewed as being concerned with two or

Figure 1.
NPD research growth in
different periods



more topic areas, proper attention was given in this study to classify them under the topic heading most closely related to what appeared to be their primary focus. Table II shows the NPD research streams for different periods.

In Table II, research stream “NPD up-front development” activities are dictated by early and late activities comprising the fuzzy front end. Early fuzzy front-end activities describe nonspecific terms like problem/opportunity structuring and/or identification/recognition, information collection/exploration, whereas late fuzzy front-end activities are seen as involving aspects of idea generation, concept development, information collection, and prescreening with new ideas (Reid and De Brentani, 2004). Research stream “NPD organizational issues” describes how NPD can be positioned in the firm’s organizational structure, organization climate, organizational leadership, etc. In general, NPD is led by a project leader formally appointed by management (termed as “general organization management” in Table II). NPD organizational issues also deal about how departmental and interdepartmental management; collaboration as well as communication; and, information transfer takes place in organizations which supports NPD.

It is observed from Table II that the variation of NPD research across different research streams is very significant ($p < 0.001$) over the time period. Among the primary classifications, the NPD superstructure (39.84 percent) comprised the most focused research area and NPD performance measures and drivers (18.19 percent) occupy the second position. On the subtopic level, process management (14.72 percent), managing technology and intellectual property (7.56 percent), strategy (7.77 percent) and general performance and success/failure drivers of NPD (7.3 percent) occupied almost 38 percent of the studies. For many topics, the distribution of topics was significantly dissimilar between three periods. In terms of percentage, topics like process management seems to be losing the attention as time progresses, where as knowledge and creativity management, departmental and interdepartmental management and collaboration, communication and information transfer have shown more attention amongst researchers from periods I to III. This rise of attention on people, teams, and their creativity was timely and highly relevant to the present intellectual economy, where human resources are becoming the most powerful weapon for organizations (Guo, 2008).

NPD research stream	No. of articles (% of articles)			Total
	Period I	Period II	Period III	
Area one: NPD super-structure	91 (35.83)	165 (42.97)	193 (39.47)	449 (39.84)
Managing technology and intellectual property	13 (5.12)	40 (10.42)	35 (7.16)	88 (7.56)
Strategy	17 (6.69)	30 (7.81)	43 (8.79)	90 (7.77)
Knowledge and creativity management	6 (2.36)	19 (4.95)	27 (5.52)	52 (4.61)
Planning and portfolio management	12 (4.72)	17 (4.43)	30 (6.13)	59 (5.1)
Process management	43 (16.93)	59 (15.36)	58 (11.86)	160 (14.72)
Area two: NPD organizational issues	26 (10.24)	36 (9.38)	67 (13.7)	129 (11.45)
Control, leadership, champion, and organization climate	6 (2.36)	4 (1.04)	10 (2.04)	20 (1.82)
Organizational structure	8 (3.15)	11 (2.86)	14 (2.86)	33 (2.93)
Departmental and interdepartmental management and collaboration	7 (2.75)	11 (2.86)	18 (3.68)	36 (3.19)
Communication and information transfer	3 (1.18)	1 (0.26)	19 (3.89)	23 (1.78)
General organization management	2 (0.79)	9 (2.34)	6 (1.23)	17 (1.45)
Area three: NPD methods and execution	20 (7.87)	48 (12.5)	50 (10.23)	118 (10.47)
Up-front development	7 (2.75)	13 (3.38)	16 (3.27)	36 (3.19)
Detail development	5 (1.97)	15 (3.9)	18 (3.68)	38 (3.37)
Co-development	8 (3.15)	20 (5.21)	16 (3.27)	44 (3.88)
Area four: NPD commercialization	36 (14.17)	43 (11.12)	42 (8.59)	121 (10.74)
Launch strategy	9 (3.54)	6 (1.56)	3 (0.61)	18 (1.91)
Launch tactics	3 (1.18)	1 (0.26)	0 (0)	4 (0.48)
Competition and external environment influence	3 (1.18)	7 (1.82)	5 (1.02)	15 (1.34)
Diffusion, adoption, and consumer's evaluation of product attributes	19 (7.48)	28 (7.29)	21 (4.29)	68 (6.36)
General launch management	2 (0.79)	1 (0.26)	13 (2.66)	16 (1.24)
Area five: NPD performance measures and drivers	55 (21.65)	61 (15.89)	89 (18.2)	205 (18.19)
General performance and success/failure drivers of NPD	19 (7.48)	24 (6.25)	40 (8.18)	83 (7.3)
Financial and market-based measures and drivers	13 (5.12)	14 (3.65)	12 (2.45)	39 (3.74)
Technical measures and drivers	15 (5.91)	8 (2.08)	29 (5.93)	52 (4.64)
Performance measurement and comparison	8 (3.15)	15 (3.91)	8 (1.64)	31 (2.9)
Area six: the emerging and enabled issues	26 (10.24)	31 (8.07)	48 (9.82)	105 (9.32)
NPD educational issues	14 (5.51)	19 (4.95)	14 (2.86)	47 (4.44)
Future research issues	2 (0.79)	5 (1.3)	5 (1.02)	12 (1.04)
Services and infrastructure of innovation	10 (3.94)	7 (1.82)	29 (5.93)	46 (3.9)
Total	254 (100)	384 (100)	489 (100)	1,127 (100)

Notes: χ^2 ; $p < 0.001$

Table II.
NPD research streams
for different periods

3.4 NPD focus on industrial, consumer, and service sectors

Many articles have investigated the market orientation of products (Dawes and Patterson, 1988; Kaynak and Kara, 2004; Hultink *et al.*, 2000; Jackson *et al.*, 1995), i.e. behavior of industrial, consumer and service products in different context to NPD. Consumer products are purchase goods of private individuals for personal consumption. In contrast, industrial products are the products purchased by businesses (industry) and public sector bodies. Service product differs from the above two categories by intangibility, i.e. services are performances rather than sensible objects (Zeithaml *et al.*, 1985).

In this section, an attempt has been made to classify the literature related to industrial, consumer and service products (Guo, 2008). Table III shows the NPD focus on industrial, consumer and service sectors along with combinations.

It is observed that two-third of articles are related to industrial products and only 10 percent of articles were devoted to consumer and service sectors together. Very few articles were found focusing on integration of different sectors and there are a significant number of articles (18 percent) which were not able to clarify which sector they were addressing which clearly shows that much research focus is required on consumer and service sectors. Table III also shows the NPD focus on industrial, consumer, and service sectors for different periods.

About two-thirds of articles in NPD research cater to the industrial sector. Therefore, an attempt was made to further classify the NPD research based on the different types of industry. Since NPD research is not restricted to any particular industry; hence, it was felt imperative to find out the range of industries and their products. All the articles were scrutinized according to the industry category involving NPD research. This classification criterion will thus help in identifying possible sectors of NPD research as well as highlight sectors that received inadequate attention of researchers. If the article deals about more than one industry, then it is termed as "multiples" and the article which was not reporting any particular type of industry were termed as "N/A". The Confederation of Indian Industry (CII) code was used for classifying the industry. The category which is not falling into the CII code was mentioned as "others". Table IV shows frequency of articles for each industry.

It is evident from Table IV that the automobile industry (14.5 percent) is the most preferred sector by the researchers and industries like aerospace, chemical, food, machinery, process and textiles were not given adequate importance. Significant numbers of articles were found in "multiples", "others" and "N/A" categories.

Further, all the above 745 industrial products related articles were categorized according to their research stream proposed in the earlier section. Table V shows various NPD research streams with respect to different industries.

3.5 NPD focus on innovation

According to Garcia and Calantone (2002), innovation is an iterative process initiated by perception of a new market and(or) new service opportunity for technology based invention which leads to development, production and marketing tasks striving for the commercial success of the invention. Invention becomes innovation only when it

Sector	Period I	Period II	Period III	No. of articles	% of articles
Industrial	178	261	306	745	66.1
Consumer	12	32	32	76	6.7
Service	9	11	18	38	3.4
Consumer and industrial	17	8	13	38	3.4
Consumer and service	1	1	1	3	0.3
Industrial and service	3	4	7	14	1.2
Consumer, industrial and service	2	3	5	10	0.9
Not mentioned	32	64	107	203	18.0
Total	254	384	489	1,127	100

Table III.
NPD focus on industrial,
consumer and service
sectors for different
periods

Industry	No. of articles	Percentage
Aerospace	32	4.3
Auto components	58	7.8
Automobile	108	14.5
Chemical	34	4.6
Electrical, electronics and telecommunication	69	9.3
Food	21	2.8
Foot ware	6	0.8
Machinery	18	2.4
Process	22	3.0
Textiles	10	1.3
Others	86	11.5
Multiples	82	11.0
N/A	199	26.7
Total	745	100.0

Table IV.
NPD research focus on
different industries

completes development and production processes further to be proved commercially successful in the market. NPD research is lagging in identifying and labeling innovation (Garcia and Calantone, 2002; Oke, 2007). In majority of the cases innovation is categorized based on either innovation characteristics or degree of innovativeness (Garcia and Calantone, 2002). In the present work, first objective is to check the percentage of articles which focus on some kind of innovation out of the all 1,127 articles selected for the study. Result shows that 44 percent (i.e. 497 articles) of the articles where focusing on one or another kind of innovation in NPD literature.

The second objective is to divide these 497 articles into triadic categorization of the innovation proposed by Kleinschmidt and Cooper (1991) and supported by Wheelwright and Clark (1992). All 497 articles were categorized into low or incremental innovation, moderate or new generation innovation and finally high or radical innovation. Low or incremental innovation refers to modifications, cost reduction and repositioning of products. Moderate or new generation innovation represents new lines to the firm and new products to the existing line. High or radical innovation focus on new to the world products and new to the firm lines, which include new to the market also. Table VI shows the summary of NPD focus at various levels of innovation for different periods.

Results shows that half of the articles focused on some kind of innovation but it was different to identify the level of innovation. The results also show that the researchers first priority was moderate innovation (28.57 percent) followed by low innovation (13.08 percent) and the least priority is the high innovation (8.25 percent).

3.6 NPD focus on development of implementation frameworks

The Reader's Digest Universal Dictionary (1987) defines framework as "structure for supporting, defining, or enclosing something; especially, skeletal erections and supports as a basis for something to be constructed" and also "a basic arrangement, form, or system". According to Shepherd and Ahmed (2000), the goal of a NPD framework is to bring product to market on time, to optimize business results by reducing cycle-time and cost, and to manage the programs according to agreed business plans over the product's life-cycle. Successful implementation of a NPD framework results in new product advantage, reduced product development cost and time to

NPD research stream	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
NPD super-structure	10	32	42	15	32	9	2	5	10	1	51	46	109	364
Managing technology and intellectual property	6	7	3	4	10	2	0	1	2	0	2	0	10	47
Strategy	0	14	11	1	6	2	0	1	1	0	10	4	26	76
Knowledge and creativity management	0	3	11	2	9	1	1	2	1	0	14	20	3	67
Planning and portfolio management	0	2	9	2	1	2	0	0	0	0	10	10	16	52
Process management	4	6	8	6	6	2	1	1	6	1	15	12	54	122
NPD organization issues	5	4	10	3	2	4	1	2	1	2	3	6	31	74
Control, leadership, and organization climate	0	0	2	1	0	2	0	0	0	0	0	0	6	11
Organizational structure	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Departmental and interdepartmental collaboration	1	1	2	0	0	1	1	2	1	1	3	5	19	37
Communication and information transfer	3	2	4	1	2	0	0	0	0	0	0	0	3	15
General organization management	1	1	2	1	0	1	0	0	0	1	0	1	1	9
NPD methods and execution	3	1	9	4	4	2	0	2	4	0	6	5	13	53
Up-front development	1	0	1	1	0	0	0	0	0	0	1	0	1	5
Detail development	2	0	2	1	1	0	0	1	2	0	1	0	4	14
Co-development	0	1	6	2	3	2	0	1	2	0	4	5	8	34
NPD commercialization	3	6	22	2	10	2	2	2	3	2	2	2	11	69
Launch strategy	0	0	2	0	0	0	0	0	1	0	2	2	6	13
Launch tactics	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Competition and external environment influence	2	0	2	1	0	1	0	1	1	2	0	0	0	10
Consumer's evaluation of product attributes	1	6	7	0	9	1	2	1	1	0	0	0	2	30
General launch management	0	0	11	1	1	0	0	0	0	0	0	0	0	13
NPD performance measures and drivers	6	11	21	7	11	4	0	6	4	4	15	16	22	127
General performance and success/failure drivers	2	8	10	5	8	1	0	3	3	3	8	6	2	59
Financial and market-based measures and drivers	0	0	6	0	0	2	0	1	1	1	2	0	6	19
Technical measures and drivers	4	2	5	2	1	1	0	2	0	0	0	6	8	31
Performance measurement and comparison	0	1	0	0	2	0	0	0	0	0	5	4	6	18
The emerging and enabled issues	5	4	4	3	10	0	1	1	0	1	9	7	13	58
NPD educational issues	1	2	3	1	6	0	1	0	0	0	9	2	10	35
Future research issues	0	0	0	0	0	0	0	0	0	0	3	2	5	5
Services and infrastructure of innovation	4	2	1	2	4	0	0	1	0	1	0	2	1	18
Total	32	58	108	34	69	21	6	18	22	10	86	82	199	745

Table V.
NPD research stream with respect to different industries

Notes: 1 – aerospace; 2 – auto components; 3 – automobile; 4 – chemical; 5 – electrical, electronics and telecommunication; 6 – food; 7 – foot ware; 8 – machinery; 9 – process; 10 – textiles; 11 – others; 12 – multiples; 13 – N/A

market offering, i.e. “first-mover” advantage. A number of NPD frameworks have been developed to satisfy the needs of different organizations operating in different markets (Shepherd and Ahmed, 2000). This raises a question of what is the focus of NPD research towards a development of framework and which research stream is more inclined

towards framework development. In the present review, it was found that 36.5 percent (411 articles) were focused on development of implementation frameworks for NPD issues. This shows that there is an enough focus towards development of frameworks in NPD research. These 411 articles are further classified according to research stream wise to explore which research streams more number of frameworks are catering to and vice versa. Table VII shows research stream wise frameworks available on literature.

From Table VII, it is clear that NPD super-structure is the research stream on which maximum number of frameworks has been developed. While very few frame works have been developed addressing NPD methods and execution. NPD methods and execution is having minimum in number but the change in percentage (+ 27.8 percent) is more for NPD methods and execution gives that development of implementation frameworks for NPD methods and execution is more in comparison to number of articles published, whereas same is reverse (− 18.42 percent) in the case of NPD performance measures and drivers, i.e. development of implementation frameworks for NPD performance measures and drivers is less in comparison to the number of articles published. At the sub topic level, the research streams which show significant positive change in percentage are communication and information transfer (+ 77.53 percent), co-development (+ 50.52 percent), detail development (+ 29.97 percent), planning and portfolio management (+ 28.82 percent) and process management (+ 20.65 percent). On the other hand, topics which shown negative change in percentage are performance measurement and comparison (− 57.93 percent), control, leadership, champion, and organization climate (− 46.7 percent), NPD educational issues (− 45.27 percent), technical measures and drivers (− 31.9 percent), future research issues (− 29.81 percent) and project managing technology and intellectual property (− 25.93 percent).

Since the number of articles have been increasing consistently (Figure 1), the number of frameworks have proposed also grown at the same rate. All these 411 framework focused articles were further arranged according to the level of innovativeness. It is observed that 213 articles (51.9 percent) in total were discussing about some kind of innovation out of which 176 articles were not able to judge the level of innovation. Very few articles were observed in literature, which discusses the different level of innovation frameworks. Table VIII shows the summary of frameworks which discusses the level of innovation.

3.7 NPD focus on performance measurement

A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions (Neely *et al.*, 2005). Importance of measuring the performance in different stages of NPD process is

Innovation type	Period I	Period II	Period III	Total
High or radical	15	19	17	41
Moderate or new generation	23	37	82	142
Low or incremental	13	19	33	65
Innovation	42	93	114	249
Total	93	168	246	497

Notes: χ^2 ; $p < 0.01$

Table VI.
NPD focus at various
levels of innovation for
different periods

NPD research stream	No. of articles	No. of frameworks	Percentage change
Area one: NPD super-structure	449 (39.84%)	176 (42.82%)	7.48
Project managing technology and intellectual property	88 (7.56%)	23 (5.60%)	- 25.93
Strategy and idea generation	90 (7.77%)	32 (7.79%)	0.26
Knowledge and creativity management	52 (4.61%)	21 (5.11%)	10.85
Planning and portfolio management	59 (5.1%)	27 (6.57%)	28.82
Process management	160 (14.72%)	73 (17.76%)	20.65
Area two: NPD organization issues	129 (11.45%)	45 (10.95%)	- 4.37
Control, leadership, champion, and organization climate	20 (1.82%)	4 (0.97%)	- 46.70
Organizational structure	33 (2.93%)	11 (2.67%)	- 8.87
Departmental and interdepartmental management and collaboration	36 (3.19%)	12 (2.92%)	- 8.46
Communication and information transfer	23 (1.78%)	13 (3.16%)	77.53
General organization management	17 (1.45%)	5 (1.22%)	- 15.86
Area three: NPD methods and execution	118 (10.47%)	55 (13.38%)	27.79
Up-front development	36 (3.19%)	13 (3.16%)	- 0.94
Detail development	38 (3.37%)	18 (4.38%)	29.97
Co-development	44 (3.88%)	24 (5.84%)	50.52
Area four: NPD commercialization	121 (10.74%)	46 (11.19%)	4.19
Launch strategy	18 (1.91%)	9 (2.19%)	14.66
Launch tactics	4 (0.48%)	2 (0.49%)	2.08
Competition and external environment influence	15 (1.34%)	6 (1.46%)	8.96
Diffusion, adoption, and consumer's evaluation of product attributes	68 (6.36%)	24 (5.84%)	- 8.18
General launch management	16 (1.24%)	5 (1.22%)	- 1.61
Area five: NPD performance measures and drivers	205 (18.19%)	61 (14.84%)	- 18.42
General performance and success/failure drivers of NPD	83 (7.3%)	27 (6.57%)	- 10.00
Financial and market-based measures and drivers	39 (3.74%)	16 (3.89%)	4.01
Technical measures and drivers	52 (4.64%)	13 (3.16%)	- 31.90
Performance measurement and comparison	31 (2.9%)	5 (1.22%)	- 57.93
Area six: the emerging and enabled issues	105 (9.32%)	28 (6.81%)	- 26.93
NPD educational issues	47 (4.44%)	10 (2.43%)	- 45.27
Future research issues	12 (1.04%)	3 (0.73%)	- 29.81
Services and infrastructure of innovation	46 (3.9%)	15 (3.65%)	- 6.41
Total	1,127 (100%)	411 (100%)	

Table VII.
Research stream wise frameworks available on literature

Level of innovation	No. of articles
High or radical	13
Moderate or new generation	17
Low or incremental	7
Not specified	176
Total	213

Table VIII.
No. of frameworks which discusses the level of innovation

highlighted by various authors in the literature (Montoya and Calantone, 1994; Driva *et al.*, 2000; Alegre *et al.*, 2006). According to Montoya and Calantone (1994) research on new product performance can be categorized into three domains: research on factors leading to success, factors leading to failure, and factors that distinguish between success and failure. Success studies mainly focuses on identifying the characteristics and factors leading to success, whereas the focus of failure studies is on analyzing the past failures and the factors correspondingly causing the failure or common pitfalls and problems in the development process. In this section, all the articles are thoroughly investigated to identify its performance focus. The article is carefully scrutinized for discussion of success or failure factors in their body of knowledge. In total 925 (82.1 percent) articles are discussing either success or failure issues of which the majority of the articles are focusing only on success factors. Table IX shows summary of performance measurement domains on NPD research.

Table IX shows that 70 percent of the 1,127 articles measuring performance, were focusing on success factors alone and a little more than 10 percent of studies were dealing about both success and failure factors. It is observed that almost there was negligible focus towards failure studies alone.

3.8 NPD focus on research design

In this section, four research designs proposed by Nakata and Huang (2005) and used by Page and Schirr (2008) and Guo (2008) are adopted to classify research design. Four research designs are formulated by combining the two typologies, i.e. conceptual versus empirical and qualitative versus quantitative to forms. Empirical-quantitative designs are mail survey, personal survey, phone survey, experiment, meta-analysis and other survey while conceptual-quantitative designs use mathematical tools to develop new models, i.e. modeling with secondary data, modeling without secondary data and content analysis. Conceptual-qualitative designs are borne from literature reviews and perspectives and arguments. Empirical-qualitative designs gather primary data through qualitative methods such as ethnography, case study, in-depth interviews, focus groups and observation. Each article was categorized into these four research designs according to its dominant research method. The summary of research design in NPD is shown in Table X.

As illustrated in Table VIII, approximately 70 percent of the articles have analyzed empirical data, while 38.9 percent of the articles could be classified as empirical-quantitative articles, which have analyzed surveys through statistical tools. A little over 30 percent of articles were found to be conceptual in total. Table XI shows the distribution of articles under different sub groups of research design in NPD research for different periods.

Performance measurement domain	No. of articles	% of articles
Success	799	70.90
Failure	5	0.44
Both success and failure	121	10.74
Not measuring	202	17.92
Total	1,127	100

Table IX.
Performance
measurement domains
on NPD research

Majority of empirical-qualitative articles that were identified reportedly used interviews followed by case studies. The trend is shown graphically in Figure 2.

Figure 2 shows in between periods I and II more focus was towards empirical qualitative, whereas from periods II to III the focus shifted towards empirical quantitative.

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Table X.
Research design in NPD:
empirical/conceptual and
qualitative/quantitative

	Qualitative	Quantitative	Total
Conceptual	193 (17.1%)	153 (13.6%)	346 (30.7%)
Empirical	343 (30.4%)	438 (38.9%)	781 (69.3%)
Total	536 (47.5%)	591 (52.5%)	1,127 (100%)

Notes: $\chi^2; p < 0.001$

Table XI.
Research design in NPD
for various sub groups
in different periods

Research methodology	Period I	Period II	Period III	Total
Conceptual qualitative	40 (15.68%)	69 (18.01%)	84 (17.17%)	193 (17.12%)
Perspectives and arguments	38 (14.9%)	67 (17.49%)	79 (16.15%)	184 (16.32%)
Literature reviews	2 (0.78%)	2 (0.52%)	5 (1.02%)	9 (0.79%)
Conceptual quantitative	37 (14.5%)	60 (15.66%)	56 (11.45%)	153 (13.57%)
Content analysis	2 (0.78%)	4 (1.04%)	2 (0.41%)	8 (0.71%)
Second data	35 (13.72%)	56 (14.62%)	54 (11.04%)	145 (12.86%)
Empirical qualitative	62 (24.3%)	127 (33.16%)	154 (31.49%)	343 (30.43%)
Case study	28 (10.98%)	48 (12.5%)	67 (13.7%)	143 (12.68%)
Interviews	34 (13.33%)	79 (20.6%)	87 (17.79%)	200 (17.74%)
Empirical quantitative	116 (45.49%)	127 (33.16%)	195 (39.88%)	438 (38.6%)
Experiments	5 (1.96%)	8 (2.08%)	6 (1.23%)	19 (1.68%)
Meta-analysis	3 (1.18%)	5 (1.3%)	6 (1.23%)	14 (1.24%)
Survey	108 (42.35%)	114 (29.76%)	183 (37.42%)	405 (35.94%)
Total	254 (100%)	384 (100%)	489 (100%)	1,127 (100%)

Notes: $\chi^2; p < 0.03$

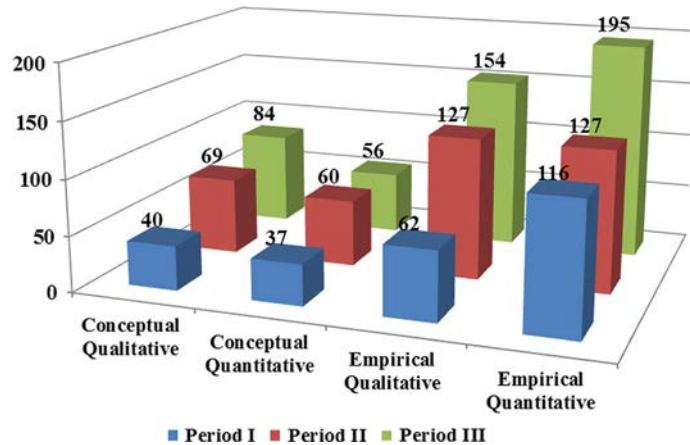


Figure 2.
NPD research design
for different periods

3.9 NPD best practices – element of exchange

According to Dooley *et al.* (2002), best practices are the tactics or methods implemented to perform chosen improvements in an organization to improve the NPD process. Further they stated that, evidence supporting the importance of these best practices varies in its strength. Some best practices have been identified as being “best” via rigorous empirical studies, while others have been identified in case studies and single-company descriptions; and some have simply been declared “best” by experts in a prescriptive manner. Managers always desire to identify and implement an optimal NPD process; hence the search for best practices is an ongoing process (Kahn *et al.*, 2006). A recent NPD best practices study (Barczak *et al.*, 2009) concluded that the best firms did not succeed by using just one NPD practice more extensively or better but by using a number of them more effectively simultaneously. Furthermore, no one practice was found to be either necessary or sufficient to guarantee that a firm was one of the best in developing new products. In this study, an attempt has been made to find the focal best practice element from each article and to explore the importance given by the researchers towards these best practice elements. Best practice elements proposed by Barczak *et al.* (2009) as part of their NPD best practices study were used as a reference to identify focal best practice element and place them under the corresponding main element. In order to identify the focal element, a list of possible elements that the article contains is laid down using title of the article and abstract. Then the element whose phrase is repeated the maximum number of times in the article is selected to be the focal element of the article. Table XII shows the summary in descending order for NPD best practice elements for different periods.

It can be easily apprehended from Table XII that NPD best practices encompasses a plethora of elements spanning under various main elements. The most frequently visited main element is technology and organizational tools supporting NPD (399 articles) followed by engineering design tools (113 articles) and NPD team and team supporting tools (94 articles). Environmental issues in NPD (23 articles) and organization structure for NPD (15 articles) are the least focused main elements amongst researchers. At sub level, the most cited elements are product design management and CAD/CAE, etc. (72 articles each), followed by voice of the customer (62 articles) and client/supplier management in NPD (53 articles). The highlighted sub elements (frequency > 2 percent) as observed from Table X represent product design management, CAD/CAE, etc. client supplier management, project management, knowledge management, simultaneous/concurrent engineering, quality function deployment (QFD), cross functional teams, voice of the customer, cycle time reduction, innovation management, service management and performance measurement.

4. Discussion

This paper, a systematic review of research literature was conducted on nine different principal NPD information groups like published journal, published year, NPD research stream, type of organization studied (industrial/consumer/service), level of innovation (high/moderate/low) NPD focus on frameworks, Performance perspective (success, failure or both), NPD research design (conceptual/empirical and qualitative/quantitative) and NPD relevant best practice element. The review enables to succinctly present status of NPD research in existing literature and chart an agenda for future research. The significant findings, gaps that were identified and the future directions will be discussed in the subsequent part of this section.

Table XII.
Frequency of NPD
best practice elements
for different periods

NPD best practice element	Period I	Period II	Period III	Total	Total frequency (%)
Technology and organizational tools supporting NPD	78	144	177	399	35.4
Product design management	9	35	28	72	6.39
CAD/CAE/virtual prototyping/web based integration	18	30	24	72	6.39
Client supplier management	11	16	26	53	4.70
Project management	10	18	17	45	3.99
Knowledge management	5	15	21	41	3.64
Innovation management	8	8	24	40	3.55
Service management	10	11	15	36	3.19
Product data management systems	1	3	11	15	1.33
Resource management systems	4	5	5	14	1.24
Rapid prototyping systems	1	3	3	7	0.62
Mathematical tools	1	0	3	4	0.35
Engineering design tools	34	38	41	113	10.03
Simultaneous/concurrent engineering	16	9	13	38	3.37
Quality function deployment (QFD)	6	11	9	26	2.31
Six Sigma analyses/quality management	6	9	5	20	1.77
Design for manufacturing and assembly/other DF "X"	2	5	6	13	1.15
Value analysis	0	3	4	7	0.62
Experimental design	3	1	1	5	0.44
Failure mode and effects analysis (FMEA)	1	0	3	4	0.35
NPD team and support tools	25	25	44	94	8.34
Cross-functional teams	13	10	8	31	2.75
Team learning	2	7	10	19	1.69
Team-building exercises	1	0	6	7	0.62
Team cohesiveness/team performance	2	2	3	7	0.62
Vide Conferencing	1	1	3	5	0.44
Team co location	2	1	2	5	0.44
Parallel development	1	0	3	4	0.35

(continued)

NPD best practice element	Period I	Period II	Period III	Total	Total frequency (%)
Groupware	0	1	2	3	0.27
Dedicated project intranet	1	0	2	3	0.27
Critical path, PERT, GANTT	2	0	1	3	0.27
Teleconferencing	0	1	2	3	0.27
Face-to-face meetings	0	0	2	2	0.18
Team composition	0	2	0	2	0.18
Market research tools	18	34	35	87	7.72
Voice of the customer	16	26	20	62	5.50
Concept tests and warranty	0	3	4	7	0.62
Lead users	0	3	4	7	0.62
Focus groups	1	1	2	4	0.35
Ethnography	1	0	1	2	0.18
Gamma testing	0	0	1	1	0.09
Alpha testing	0	0	1	1	0.09
Customer site visits	0	0	1	1	0.09
Beta testing	0	0	1	1	0.09
Product positioning	0	1	0	1	0.09
NPD strategy	23	28	33	84	7.45
Cycle time reduction	11	15	13	39	3.46
Competitive advantage	4	5	7	16	1.42
First-to market	2	3	4	9	0.80
Reduction in cost	2	2	4	8	0.71
Fast-follower	2	1	4	7	0.62
Reactive	1	1	1	3	0.27
Niche	1	1	0	2	0.18
Product launch	20	23	32	75	6.65
Product launch cycle time	7	2	5	14	1.24
Promotion expenditure	2	10	1	13	1.15
Launch strategy for new products	3	2	7	12	1.06

(continued)

Table XII.

Table XII.

NPD best practice element	Period I	Period II	Period III	Total	Total frequency (%)
Marketing strategy for product launch	3	3	5	11	0.98
Planning of innovativeness in product launch	1	2	7	10	0.89
Post launch feedback mechanism	1	1	2	4	0.35
Targeting to the specific product	1	2	0	3	0.27
Launch strategy for repositioned products	0	0	2	2	0.18
Launch breadth of portfolio	1	0	1	2	0.18
Branding of product	0	0	2	2	0.18
Pricing policy	1	1	0	2	0.18
NPD outcomes and commercialization	19	19	25	53	4.7
Performance measurement	4	12	15	31	2.75
Performance modeling and simulation	1	4	4	9	0.80
Technology commercialization and testing	3	2	3	8	0.71
Product customization	1	1	3	5	0.44
Idea generation	4	23	19	46	4.08
Formal innovative planned activities to fill gaps	2	5	6	13	1.15
Formal planned activities-need more ideas	1	6	2	9	0.80
Informal activities to fill gaps	1	3	4	8	0.71
Without prompting	0	5	2	7	0.62
Informal activities-need more ideas	0	3	3	6	0.53
Formal innovative approach using AI	0	1	1	2	0.18
Formal innovative approach	0	0	1	1	0.09
Product architecture	13	13	15	41	3.64
Modular	5	8	6	19	1.69
Platform based	7	3	5	15	1.33
Integral	1	1	2	4	0.35
Product architecture assessment	0	1	2	3	0.27
Collaboration mechanisms	7	13	13	33	2.93
Alliances	2	6	9	17	1.51
Joint ventures	2	4	2	8	0.71
Outsourcing	3	3	2	8	0.71

(continued)

NPD best practice element	Period I	Period II	Period III	Total	Total frequency (%)
The fuzzy front end				32	2.84
Conceptual design	5	4	8	17	1.51
Early phase product evaluation	6	1	2	9	0.80
Business case analysis	2	1	3	6	0.53
Portfolio management	6	6	20	32	2.84
New-to-the-firm	1	1	4	6	0.53
Improvements	1	1	4	6	0.53
Cost reduction	1	0	5	6	0.53
New-to-the-world	2	0	3	5	0.44
Repositioning	1	1	3	5	0.44
Additions to existing lines	0	1	1	2	0.18
Portfolio evaluation	0	2	0	2	0.18
Environmental issues	2	7	14	23	2.04
Recycling	1	4	8	13	1.15
Disposal	1	2	4	7	0.62
Reproducing	0	1	2	3	0.27
Organization structure for NPD	2	5	8	15	1.33
New product department	1	1	2	4	0.35
New product committee	0	2	2	4	0.35
Project management	0	0	3	3	0.27
Dominant function	1	1	0	2	0.18
Distinct division/venture	0	1	1	2	0.18
Total	254	384	489	1,127	100

Table XII.

4.1 Significant findings

- Research stream “NPD super-structure” contributes the highest to the NPD research followed by NPD performance measures and drivers. The results of our study differ with the findings made by Guo (2008) in terms of percentage and priority. This is understandable given that Guo (2008) focused on only one particular journal for their study. But both the studies completely agree that more attention is required towards knowledge and creativity management, departmental and interdepartmental management and collaboration, communication and information transfer in any NPD process.
- In reviewing all 1,127 articles, it was observed that the distributions of research streams are significantly dissimilar between the various periods under study. Research topics like NPD process management seems to be losing the attention as time progresses, where as knowledge and creativity management, departmental and interdepartmental management and collaboration, communication and information transfer have shown more attention amongst researchers as time progresses. Research issues like communication/information transfer and product launch management have gained the highest attention in the recent four year period.
- NPD research issues like product design (i.e. methods and execution), process design, and strategy at different levels have been significantly dealt in literature. On the other hand, NPD organizational issues such as leadership, organization climate, organizational structure and management, departmental and interdepartmental collaboration management and information transfer are not adequately addressed.
- NPD research worldwide has been seemingly focusing on the industrial sector. In the present review, the authors found that the proposed industry specification were either too broad or too narrow. Defining the industry too broadly obscures differences among products, customers, or geographic regions that are important to analyze competition, strategic positioning, and profitability. On the other hand, defining the industry too narrowly overlooks commonalities and linkages across related products or geographic markets that are crucial to analyzing competitive advantage (Porter, 2008).
- It is also observed that a significant amount of focus amongst researcher’s focused on innovation aspects of NPD research. About half of the articles surveyed focused on some kind of innovation but the same articles were not able to mention precisely about the level of innovation. This result supports the studies of García and Calantone (2002) and Oke (2007), i.e. in general, NPD research is lagging in labeling the level of innovativeness. One major lagging issue in product innovation is the lack of widely accepted cross-cultural studies in marketing and consumer behavior and the effect of innovation on economies over time (Karniouchina *et al.*, 2006).
- Based on the survey, the first priority amongst researcher’s is moderate innovation or new generation innovation which represents new lines to the firm and new products to the existing line, followed by low innovation or incremental innovation refers to modifications, cost reduction and repositioning of products. The researcher least priority is the high innovation or radical innovation refers to new to the world products and new to the firm lines, which include new to the

market also. Furthermore, additional research focus is needed towards developing new to the world products and new to the firm lines, which include new to the markets, new to service, etc.

- NPD research has been produced a good number (411 out of 1,127) of frame works. It is observed that majority of the frameworks were from “NPD super-structure” which discusses about managing technology, strategy, knowledge management, portfolio management and process management. Only a handful of these frameworks focused on emerging and enabled issues and those that have considered such aspects are limited to the development of implementation frameworks.
- The availability of NPD frameworks are scarce as compared to the vast number of literature available that addresses NPD specific issues like technology management, NPD organization issues (leadership, organization climate, organization management), technical measures/drivers and performance measurement.
- The existing NPD frameworks appear to be as a synthesis of implementation related issues rather than any fundamental failing of the NPD framework (Shepherd and Ahmed, 2000). There has been an effort in the literature to develop NPD frameworks, which tackle a whole range of activities for effective product development but still there is a scope to improvement.
- So far as NPD performance issues are concerned, success factors have dominated the focus of investigation while both success and failure factors have got scant attention in literature. It is clearly observed that studies on failure factors in NPD projects or programs are reasonably unaddressed in the existing literature.
- NPD research reports the presence of empirical to conceptual studies in the ratio 7:3 while the ratio between empirical quantitative to empirical qualitative stands at about 4:3. It is also found that NPR research is more biased towards empirical quantitative, especially most of the NPD studies are based on survey questionnaire method (36 percent). In fact the most recent period had the highest percentage of empirical quantitative. It is noticeable that other empirical methods, such as interview and secondary data, were used much less frequently. Moreover, it is hard to find a articles on experimental methods in NPD research.
- Jiao *et al.* (2007) reported that substantial progress has been achieved in the areas of product family design optimization, product family configuration, modular architectures, and product portfolio planning but the present study slightly disagree with the report because it is observed that fewer than 2 percent of articles investigated on the best practices on each of the above said topics.
- NPD best practice elements frequency study reports that product design management, CAD/CAE, etc. client supplier management, project management, knowledge management, simultaneous/concurrent engineering, QFD, cross functional teams, voice of the customer, cycle time reduction, innovation management, service management and performance measurement have managed to get more attention by the researchers. However, Barczak *et al.* (2009) reports that no one best practice can be either a necessary or sufficient condition to guarantee a firm as one of the best in developing new products. And also such best practice companies are more likely to have first-to-market innovation strategies, use of more formal processes for generating ideas, managing collaborations

with other firms, multiple functions team, the ability to work together as a team, supporting team leaders, obtaining needed support from functional and senior managers. They also state that the best are more likely to test and implement many different kinds of NPD tools for qualitative marketing research and engineering design tools such as value analysis, design for X, rapid prototyping, and Six Sigma.

4.2 Research gaps identified

- (1) NPD research has primarily focused on coordinating activities across product design, manufacturing process design, and supply chain design but do not address how to maximize operational, supply chain, and firm performance through this coordination (Rungtusanatham and Forza, 2005).
- (2) It is observed from the results of NPD research methods that the methodological approach of NPD research is strongly biased towards quantitative surveys, large samples and extensive statistical analyses. This result is general conclusions without managerial implications that may lead to implementation difficulties. Similar observation was made by Biemans (2003) and the author further reported that many academic journals emphasize on data analysis, leading to articles with only minor sections on managerial implications that only summarize the statistically significant factors, failing to offer practitioners clear clues about how to handle implementation.
- (3) NPD research worldwide has been seemingly focusing on the industrial sector. The importance of services to the global economy has grown steadily while the importance of goods has declined (Berry *et al.*, 2006). Both service and product support are increasingly critical elements in the achievement of customer satisfaction and winning new markets (Kumar and Kumar, 2004), hence it is very much imperative to give more attention towards service related issues in NPD. Page and Schirr (2008) also reported that a dramatic increase in research on new service development in the years ahead is long overdue. The same authors further state that both conceptual and empirical analysis of new service development including both qualitative and quantitative techniques should be employed in the effort to understand the unique characteristics of NPD in service sector.
- (4) Shepherd and Ahmed (2000) stated that successful implementation of a NPD framework could lead to numerous gains in the effectiveness of the NPD by:
 - reducing product development costs;
 - time to market offering “first-mover” advantages; and
 - new product advantages.However, whilst much has been made of the advantages and benefits through adoption of such encompassing frameworks, there remains considerable scope for improvement. Indeed, experiences of implementing such frameworks highlight numerous negative side-effects (Shepherd and Ahmed, 2000). Companies need to carefully balance the benefits against the costs of implementation before embarking upon any programme of action.
- (5) The present study observed that NPD process management seems to be losing the attention as time progresses. This down trend may be because of the fact that formal processes are now no longer the norm and having a formal process

is no longer a differentiator, and many firms have moved to third-generation types of NPD processes (Barczak *et al.*, 2009). The same study by Barczak *et al.* (2009) is also revealed that processes for radical projects are more complex than for incremental projects. Firms have moved from implementing NPD processes to help manage individual projects to implementing portfolio management processes to help manage multiple projects simultaneously. Research on this direction is clearly promising and long overdue.

- (6) NPD process measures used in many of the organizations were concerned with revising the outcome of the individual project and integrated the NPD effort, rather than providing guidance on what needs to be consistently measured to ensure they remain successful (Rogers *et al.*, 2005). The authors argue that no one set of measures would remain definitive over the time; therefore there must be constant effort to develop more implementation frameworks on performance measurements since enough literature is available to do so.
- (7) Barczak *et al.* (2009) reported that, although firms had implemented a number of new methods and techniques to improve the way new products have developed in the recent years, very little absolute progress in success rates had been made, i.e. success rates were stable at around 59 percent, which clearly shows that failure rates are also constant. Since NPD research has given more attention towards success factors, it is also important to study and report the failure factors at product or project level in NPD.
- (8) Research on NPD performance have focused more on identifying and validating the various success factors at product and project level but they do not distinguish between different factor levels, i.e. how factors are interrelated and influence NPD success.
- (9) Since NPD issues like leadership, organization climate, organizational structure and management, departmental and interdepartmental collaboration management, information transfer and idea management were the least studied research issues, the present study is in agreement with the report of Barczak *et al.* (2009), i.e. NPD areas like idea management, NPD project leadership and training, cross-functional training and team communication support, innovation support and leadership by senior management needs to be seriously improved.
- (10) The review NPD best practices revealed that, there is a great amount of discrepancy in the focus of NPD research in literature so far as understanding what the best companies really practice. For example, most of the best companies follow first to market strategy where the much addressed research strategy issue was cycle time reduction. The study by Barczak *et al.* (2009) reported that collaboration with other firm is a best practice, which has gained little attention in the existing NPD research. Hence more attention is required towards best practice elements like the practice of how NPD teams are assembled, trained, enabled, supported, and managed in practice; product development strategy; formal idea generation methods; qualitative market research; and engineering design tools such as value analysis, design for X, rapid prototyping, and Six Sigma, etc.

4.3 Future directions

- (1) Research topics like managing technology and intellectual property, managing the innovation in NPD process and innovativeness in NPD process at organizational level are promising areas for future studies. Since no company could develop all the necessary technologies by itself (Guo, 2008), technology management in NPD will require addressing issues such as how firms obtain technological superiority by using external sourcing and how they effectively protect their intellectual properties because of today's business circumstance characterizing fierce competition and high-velocity change.
- (2) Today's markets are global in scope hence to succeed in global markets, companies need strategies that incorporate the right degree of globalization in terms of both market coverage and product offering (De Brentani *et al.*, 2010). To address this, various issues like NPD strategy, NPD speed, market orientation in NPD process, building the innovation culture in NPD process, interactions among different NPD activities and external environment uncertainty needs to be investigate at global level.
- (3) Integration of various stake holders like "voice of customers", supply chain, sales force, focus groups and various firm's NPD cross functional teams into the NPD process is thoroughly addressed in literature. Future research could be on integration of all these stake holders together into the NPD process in a structured way to improve the product development resulting in increase in customer satisfaction and operating profits.
- (4) The research gap between NPD research and NPD practice requires further research. Here we will have to investigate implementation issues and different presentation of NPD results in for various types of manufacturing organizations, i.e. make-to-stock (MTS), make-to-order (MTO), assembly-to-order (ATO) and engineer-to-order (ETO).
- (5) Future NPD research designs would require a combination of both quantitative and qualitative approaches to overcome the qualitative bias that exists in survey results. Biemans (2003) argues that understanding issues can be identified from quantitative data which further cab be studied in detail by qualitative research. Another research focus would be on conceptual studies on multidimensional constructs of NPD at various stages in the NPD process and further validation of constructs using the qualitative research.
- (6) NPD performance research have to focus on comparing the performance measurements:
 - between innovative and non innovative industries;
 - between two emerging economies such as those in the Far East and the Indian subcontinent (Rogers *et al.*, 2005); and
 - between the developed and developing economies, to enhance the understanding of process variations across industries and cultures.
- (7) To improve the effectiveness of NPD process, future research should focus on development of implementation frameworks on research issues like technology management, NPD organization issues (leadership, organization climate,

- and organization management), technical measures/drivers and performance measurement both at domestic and international NPD projects.
- (8) Cross-cultural efforts in marketing and consumer behavior should be accounted for product innovation. So, research needs to focus on the major drivers of innovation and its effect on economies over time (Karniouchina *et al.*, 2006).
 - (9) In the present review various NPD best practice elements were identified and reported. Further investigations cab made to identify which of these deserves recognition as a best practice along with corresponding implications for various types of organizations.
 - (10) The decisions at various stages in NPD will depend on several quantitative and qualitative factors. Extensive multi-criteria decision making approaches have been proposed in different stages, such as the analytic hierarchy process (AHP), analytic network process (ANP), case-based reasoning (CBR), data envelopment analysis (DEA), fuzzy set theory, genetic algorithm (GA), mathematical programming, simple multi-attribute rating technique (SMART), and their hybrids. Another future study on NPD could focus on different multi attribute models and their application on different stages of NPD to describe the approaches more prevalently applied, to identify which evaluating criteria were paid more attention and any inadequacy in the approaches, etc.
 - (11) The present study does not attempt to trace out data trends using regression techniques neither it endeavors' to test the hypothesis across various research streams for establishing a grounded theory, that could lay down a perfect platform for future research.

5. Conclusions

The paper reviewed 1,127 articles on NPD with multiple objectives like growth of NPD research; growth in identified research streams; exploring the NPD research focus towards various issues like of innovation, framework development and performance measurement in NPD research; list and classify the NPD best practices elements and to show the changes and trends over the time period as and when required. In the study period, only ten journals have published more than 20 articles on NPD which shows that there is a certain level of dispersion in the publication of the NPD. The paper also highlights the growth NPD research. This study on NPD research also identifies the sector wise growth in NPD research *vis-à-vis* industrial, consumer and service sectors. It is observed that many researchers have failed to judge the level of innovativeness in NPD research and in the classified literature more focus was observed towards moderate innovation. An attempt has been made to explore the focus towards framework development in terms of number of articles published and inadequately addressed issues were highlighted. NPD performance issues were dominated by focus towards success factors. Review also revealed important and frequently visited issues in NPD along with highlighting all the inadequately addressed issues into limelight in the form of significant findings, research gaps and future directions.

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