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SIGNIFICANCE OF INDUSTRIAL ENGINEERING COMPETENCIES TO INTRODUCE NEW AUTOMOTIVE VARIANTS: A STUDY PERSPECTIVE

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Abstract

This study will review and analyse the implications of industrial engineering (IE) practicesas key organizational competencies to introduce new variants in the domain of Indian automotive sector. In the present scenario, increased competition in the automotive domain among original equipment manufacturers (OEMs), demanding customers, regulatory pressures (e.g., emission control, energy efficient vehicles and passenger safety and so on.), fluctuations in global vehicle demand, proliferation of model variants, and low capacity utilization of OEMs are the various challenges experienced by automotive manufacturers. This study highlights these challenges which urge to develop a conceptual framework in order to successfully introduce the new automotive variants. The outline of this study towards this conceptual framework is to determine and establish the key industrial engineering competencies towards successful and rapid introduction of new automotive variants by the automotive manufacturers in the business of Indian automotive sector.

Keywords: New Product Development, Industrial Engineering Competencies, New Automotive Variants, Automotive Domain

1. INTRODUCTION

In response to the competitive market in automotive businesses, regulatory pressures on energy efficiency, passenger safety, emission control, rapidly changing technologies, shorter product life cycle, proliferation of model variants and variance in choices among demanding customers, the original equipment manufacturers (OEMs) from India, in the automotive domain are attempting to increase their research and development (R & D) efficiencies, in terms of rapid development and launch of new model variants.

Over the past two decades, several researches conducted in the area of new product development (NPD) in reference with Cross (2007) have indicated that this competency is associated with very complex business processes that cut across functional boundaries and require industry-specific knowledge to launch feasible solutions that are commercially viable. Based on the study done by Sanongpong (2009), starting from idea generation and screening, concept development, and business analysis, NPD includes product and process design, development, testing and validation followed by product launch, feedback assessment and corrective action. While some of these activities may overlap because of the inherent correlation between them, many tasks are performed concurrently to optimally utilize the available resources and make the entire process more efficient.

Most of the recent studies on the success of NPD have focused in isolation the need for various technological, marketing and design capabilities, quality assurance, and management practices in different industry sectors across large and small organizations in different countries. However, an all-encompassing academic study taking into consideration the interaction, integration and harmonization of various capabilities and competencies that culminates in organizational core competencies in accordance with Barney et al. (2011) for achieving excellence and success in NPD in the automotive domain for a developing country like India is limited in the extant literature.

Hence, this study is concerned with the identification and determination of the set of IE competencies, and the review and analysis of the relative importance of the capabilities associated with these competencies aimed at the successful and rapid development and launch of new automotive model variants in Indian organizations engaged in the business of design, manufacturing and marketing of light commercial vehicles (LMVs).The scope of this work is limited to the study of automotive manufacturers with respect to competencies required for the introduction of new automotive variants in the business of Indian automotive domain.

2. MOTIVATION TOWARDS THE STUDY

Well (2013) inferred that there would be an urgent need to understand more clearly the scope and barriers to growth afforded by business model innovation, both in the automotive industry and more widely particularly with respect to sustainability. As per the news published by Progressive Digital Media Transportation News (2014), German automobile manufacturer British Motor Works (BMW) had introduced a new variant of its sports activity coupe, the BMW X6 being available from December 2014 in its three variants - BMW X6 xDrive50i, BMW X6 xDrive30d and BMW X6 M50d. The features of BMW X6 models would include adaptive LED headlights, comfort access including hands-free tailgate opening and closing, the navigation system with touch controller, Bang &Olufsen surround-sound system and new rear entertainment system. According to Kley et al. (2011), activities have been initiated in all the domains but these are often being realized as pilot ventures with undefined/unclear business model structures. The strategy and the creation of new business models requires an embedded understanding of products and sectors alongside a 'whole system' perspective, as per the analysis done by Wells (2013) in this sector, and potentially in others too. From the viewpoint of these discussions, the need to address and establish the key IE competencies arises so as to successfully and rapidly introduce the new automotive variants in the competitive market of Indian automotive business.

3. SIGNIFICANCE OF INDUSTRIAL ENGINEERING (IE) COMPETENCIES TO INTRODUCE NEW VARIANTS

The IE competencies are a set of integrated key capabilities which are unique, inimitable, non-substitutable, and flexible for re-configuration and re-deployment to introduce the new automotive variants. The key IE competencies that will be having an effective role for the successful and rapid introduction of new automotive variants in the business of Indian automotive domain are being discussed through the literature support.

3.1 Design and Delivery Competencies (DDC)

Owen et al. (2011) conceptualized a new approach of integrated design and delivery competency (DDC) solutions that aim to radically improve performance with the application of innovative processes, such as integrated project delivery. Although, these innovations are seen to develop in isolation, with little consideration of overarching interactions between people, process and technology. In context to DDC, the key issue according to Davis et al. (2011) in creating value is to provide benefits (including access to resources and capabilities) that are perceived by the customer to be greater than costs, which includes money, time, and effort, associated with obtaining these benefits. Zeithaml (1988) addressed in DDC that perceived customer value had been categorised into three broad aspects - low cost, experience, and innovation.

3.1.1 Prototyping and Testing Capability (PTC)

As discussed by Lantada and Morgado (2012), prototyping and testing capability(PTC) is referred to as a new set of technologies to address the market requirements in a customized way and to provide support for research tasks that require prototypes to allow researchers to generate prototypes i.e. physical parts in a wide range of materials with remarkable precision in a short span of time (within hours or days), directly from designs created via computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM) programs. These technologies facilitate the creation of complex geometries, including inner details, carried out directly from the associated CAD files.

3.1.2 Concurrent Engineering (CE)

Avnet and Weigel (2010) discussed about the concept of concurrent engineering (CE) as a design capability on an integrated basis in the sense that the various discipline engineers (usually one per discipline) are collocated in the same room so that they are able to concentrate their efforts on the truly interdisciplinary aspects of the design. Prasad (1996), Sercel, Sepahban, and Wall (1998), and Karpati (2003) analyzed the significance of CE capability as the core design competency that increases the pace of conceptual design by bringing together all relevant personnel to conduct focused, collaborative one-week design studies.

3.1.3 Technology Management Capability (TMC)

Taguchi (1993) conceptualized the 'technology management capability (TMC)' as “robust technology development process that encompasses the technological readiness, flexibility, and reproduceability'. Based on the implication of the study by Cho and Lee (2013), as the number of new products developed by new technologies has increased, the importance of the commercialization of new technology products has become crucial to manufactures in the successful delivery of valuable new products and services.

3.1.4 Flexibility (F)

As per the definition laid out by Taguchi (1993), 'flexibility' means the ability of the technology to be adjusted for actual production processes. Swafford et al. (2006) and Chiang et al. (2012) defined 'flexibility' as a design competence built by an organization to be able to change or react with little penalty in time, cost, or performance.

3.2 Transformational Competencies (TC)

Zhang and Lado (2001), and Lado and Wilson (1994) had identified one of the vital organizational competencies - transformational competencies (TC) as one of the potential sources of firm's sustained competitive advantage. These authors had defined 'TC' as “organizational capabilities required to advantageously convert inputs into outputs” which encompass innovation and entrepreneurship, organizational culture, and organizational learning, and plays a significant role in harnessing innovation and entrepreneurship, fostering organizational learning, and promoting an innovation-based organizational culture. Barney (1992), Lado and Wilson (1994), and Peteraf (1993) all of these authors stated that TC allowed firms to establish a unique product market position. Lawton and Michaels (2001) addressed this aspect of TC as the organization's core competencies that offers an organization a tool to achieve cost reduction, competency enhancement and revenue generation/growth implying strategic outsourcing, and as the paradigm shift away from a relatively indirect (even remote) relationship between the firm and its consumers and towards a direct interface between the organization and its customers.

3.2.1 Value Engineering (VE)

Mukhopadhyaya (2009) summarized the theory of VE given by LD Miles as “an organized creative approach that has for its purpose the efficient identification of unnecessary cost, that is, cost that provides neither quality nor use nor life nor appearance nor customer features”. Being referred by Cooper &Slagmulder (1997), VE is a systematic, interdisciplinary examination of factors affecting the cost of a product so as to devise means of achieving the specified purpose at the required standard of quality and reliability at the target cost. As inferred by ElMaraghy et al. (2012), VE techniques are the qualitative approaches used by the engineers to reduce the complexity in engineering design.

3.2.2 Reverse Engineering (RE)

Eilam (2005) explained the concept of reverse engineering (RE) as “the process of extracting the knowledge or design blueprints from anything man-made, which is usually conducted to obtain missing knowledge, ideas, and design philosophy when such information is unavailable” as such, traditionally, RE has been about taking shrink-wrapped products and physically dissecting them to uncover the secrets of their design wherein such secrets were then typically used to make similar or better products.

According to Villaverde and Banga (2014), 'RE' is aimed to infer, analyse and understand, through the interplay of mathematical modelling with experiments, the functional and regulatory mechanisms of a system.

3.2.3 Innovation Capability (IC)

Im and Workman (2004) inferred 'IC' as a critical factor that determines new product success as such, can differentiate a new product from competitive offerings and enable the product to achieve a unique positioning in the marketplace. According to Garcia and Calatone (2002), 'IC' refers to the degree of "newness" of an innovation, whether newness to the world, to the industry/market, or to the firm.

3.2.4 Knowledge Management (KM)

Verhagenet al. (2012) conceptualized the term 'knowledge management (KM)' as "Knowledge-Based Engineering (KBE)" or in generic term as "engineering knowledge management (EKM)" which has been linked with the "design automation". Chandrasegaran et al. (2013) gave the definition of 'KM' as "a capability to capture and reuse knowledge in an organization, can be used to integrate onto logical structures into design process management'.

3.3 Relational Competencies (RC)

Paulraj et al. (2012) defined relational competencies (RC) as one of the core organizational competencies that influence the patterns of SCM practice and can improve the performance of a supply chain. Various studies including Chen et al. (2004), Fabbe-Costes and Jahre (2007), Omar et al. (2012), Paulraj et al. (2008), Paulraj et al. (2012) and Swink et al. (2007) had specifically revealed about the significance of three relational competencies - cooperation, integration and communication in prior literature studies.

3.3.1 Coordination and Collaboration Capability (CCC)

In view of the literature support by these researchers - Gulati et al. (2012), and Olorunniwo and Li (2010), coordination and collaboration capability (CCC) is an "effective alignment and adjustment of partners' actions" in the context of inter-organizational collaboration which is almost impossible if not preceded by intra-firm coordination through information sharing as such, the two phenomena play out very vital and critical roles in the partner selection, design, and post-formation stages of an alliance's life cycle.

3.3.2 Branding Capability

In context to branding capability (BC), as per the interpretations from Day (1994) and Atuahene-Gima (2005), market launch capability, which refers to the firm's ability to design and implement new product launch activities effectively, should affect innovation performance. Being referred by Best (2009), and Luchs and Scott Swan (2011), other studies have argued that beyond branding, "design is one of the primary idea generators for the creation of viable business platforms". Overall, product design is increasingly recognized by managers as an important strategic tool which had been addressed by Brunner et al. (2008) as a relevant aspect being responsible for the success of firms such as BMW which establishes itself as a benchmark and being a pioneer in the business of automotive domain by setting an example.

3.4 Management Competencies (MC)

As per the explanation laid out by Zirger and Maidique (1990), top management initiative and support is a key aspect in order to achieve new, product innovativeness and profitability. Based on the observations with respect to several studies in accordance with Lacity et al. (2012) in the area of NPD, human resource management capability of an organization have positive influence on knowledge management, innovation, design and development, flexibility and new product innovativeness.

3.4.1 Product Development Strategy (PDS)

In the context of 'PDS' and launching of new automotive variants based on the study done by Cullen et al. (2005), this capability enables an organization to put in place innovative marketing and service strategies for selected customer segments with special emphasis on innovative products and adoption of appropriate risk mitigation measures.

3.4.2 Human Resource Management (HRM)

In the context of development of new automotive variantsin consultation with Levina and Ross (2003), the attributes of 'HRM' that matter the most are the organization's abilities to attract and retain talented as well as experienced professionals and to foster an environment of innovation through effective collaboration and deployment of knowledge management system.

4. CUSTOMER PERCEIVED VALUE (CPV) - A SURROGATE MEASURE OF NPD SUCCESS

CPV is considered as a mediator variable based on the interpretations by Swinarski et al. (2006), which acts as a surrogate measure of NPD success to introduce new automotive variants. It impacts an organization's business performance measures in terms of customer retention, repeat orders, and revenue growth through the customer references.The value of products perceived by the customers is equivalent to the benefits that the customers get from utilizing a product or service which exceed what it costs to acquire and use it.These benefits expressed as the CPV are derived in terms of safety (S), reliability (R), sales and service support (SSS), and conformance to regulatory norms (CRN), which are the outcomes from the implications of key IE competencieson successfully introducing the new automotive variants in the competitive market of automotive domain.

4.1 Safety (S)

From the viewpoint of Dieter and Schmidt (2017), 'safety (S)' involves designing products that will not injure people or damage property, and "a safe design is one that instills confidence in the customer and does not incur product liability costs. Based on the studies conducted by these researchers –Delaney et al. (2005), Fleming and Silady (2002), and Ahmed et al. (2011), a desire level of safety has to be achieved in safety-critical systems for which the design process encompasses bare-bones design, add-on design, and the reliability analysis of the entire system and they are performed with the feedback between each other.

4.2 Reliability (R)

As discussed by Dieter and Schmidt (2017), 'reliability (R)'measures the ability of a component or system to operate

without failure in the service environment which is expressed as the probability of the component functioning for a given time without failure'.

4.3 Conformance to Regulatory Norms (CRN)

The related points of interest cover control of environmental pollution, ease of disposal of the product at the end of its productive life cycle, reduction of noise and incorporation of adequate and appropriate safety measures (e.g. anti-lock braking system, seat belt reminder, child lock functionality check, air bags, conformance to frontal crash test norms at 64 Km/hr, etc.), as per the norms laid out by Central Motor Vehicle Rules (CMVR, 1989), and Bharat New Vehicle Safety Assessment Programme (BNVSAP, 2017).

4.4 Sales and Service Support (SSS)

Saccani et al. (2007) highlighted the relevance of these attributes that extend the value of a product, and improve the 'experience' a customer derives from purchasing and using the product. The sales support covers not only the case with which the product is made available to the customers but also the necessary guidance and training required for successfully using the product while the service support works on the resolution of complaints received during the emergent phase of a product.

5. SUCCESS MEASURES FOR PRODUCT INTRODUCTION (SMPI)

These are the indicators to reflect the performance of an organization's business over a period of time. In the context of a new product development and launching in the market by a firm, the incremental changes in the value of these measures over a period (usually ranging from six to twelve months) indicate whether the new product development and launching has been successful or not. The measure of success to introduce new variant is usually evaluated along multiple matrix. One of the best measures of success to introduce new automotive variants in the business of automotive domain will be encompassing time-to-market (TTM), diffusion rate (DR), and revenue growth (RG).

5.1 Time-To-Market (TTM)

As per the discussion by Dieter and Schmidt (2017), for many of the consumer products, the more valued product will occupy the market first and thereby, much focus and attention is required to minimize the 'TTM' urging for the necessity of some sort of project (development) team to target the reduction in TTM as such this will lead to three vital competitive advantages - extended product's life, increased market share, and higher profit margins.

5.2 Diffusion Rate (DR)

According to Driva et al. (1999), and Al-Alawi and Bradley (2013), DR of a new automotive variant can be measured by the rate with which the new product is accepted by the market which also, indicates the level of acceptance of the product by the consumer.

5.3 Revenue Growth (RG)

A growth in this measure means that there has been an increase in the level of adoption of the product variant because customers have found it more useful compared to the price level in accordance with Griffin and Page (1996), and Pauwels et al. (2004).

6. CONCLUDING REMARKS

The insights from this study will develop a conceptual framework to successfully introduce the new automotive variants in the competitive market of Indian automotive sector characterized by a high level of customer acceptance and reduced time-to-market with an incremental rise in revenue growth. The ability to quickly introduce the new automotive variants by the means of best industrial engineering practices as the key organizational competencies in the business of automotive sector will become not only one of the key determinants for business transformation but also the primary enabler for survival and growth for most of the Indian companies in the automotive domain.

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