

Modelling R&D Strategy to Fulfil Customer Demands through Digital Transformation

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Abstract: - Digital transformation enables companies to build their innovation strategies for implementing various digitalization tools in their processes to meet current and future customer demands. Today's market is fed by several customer trends such as personalization of products, environmental awareness through product design, responsiveness and proactivity of the brand. These customer demands create challenges for companies. Digital transformation offers advantageous tools to fulfil the challenges. This study proposes a framework for investigating optimum innovation strategy decisions of companies among available digitalization tools. Further in this work, a decision model is developed, and an illustrative example is given with current customer demand which is gathered by a survey with sales specialist. The decision model clarifies the strategic decision of digitalization investments of the companies, the case study is conducted in automotive industry. The decision model could be applied for any other sector which demands to conduct customer-driven innovation through digital transformation.

Keywords: - R&D Management, Customer-Driven Innovation, Digital Transformation

1 Introduction

Digital transformation influences market and customer expectations. Industries are challenging for robust adaptation of technology to fulfil customer demands. Innovation management becomes a crucial vision for the companies to keep and increase their market volume. Therefore, they are supposed to share large volume of investments to this section. However, innovation aspects are numerous and complex.

Digital transformation offers advantageous tools for companies to survive in the competition. "Digital Factories" is described [1] as one of the key links in the digital manufacturing technology, hence digital factories solve the main product design. In addition to the digitalization tools on manufacturing such as automation and 3d computer aided design (3d CAD), there are customer relationship management (CRM) tools and big data applications which provides the opportunity to track customer behavior to the companies.

The developed decision framework defines the most advantageous digitalization tools for the case sector. It can be used either by sectors or by a specific company integrating customer demand information. This decision will shape company's road map in digital transformation of industry through customer-driven innovation.

The paper gathers information from 3 perspective namely "customer demands through marketing trends", "company processes to supply and to manage products", "technology fed by digital transformation". These are processing in a decision making model which is created employing quality function deployment (QFD) [2]. As the output, one of the alternative digitalization tools is pointed to the company for further development. By following the order of the importance degrees, the company would sustain digital transformation by conducting customer-driven innovation.

While creating the decision model, desk research is performed as well. In this step, current customer demands are investigated from marketing reports of several marketing magazines such as Forbes, Fortune and Entrepreneur. Moreover, company processes are classified in product lifecycle management (PLM) methodology [3]. PLM framework is divided to sub-sections inspiring the example [4].

Lastly in desk research, current digitalization aspects are investigated from sources such as production infrastructure company reports (Siemens, Inglobe Technologies), relative reports (<http://www.futuresme.eu/>), survey of Massimo Zanardini from University of Brescia named "The Digital Manufacturing Revolution" and papers [5] and [6].

The rest of the study is organized as follows. The following section provides basic notions of digital transformation. Section 3 provides the proposed decision framework. Final section delineates finding, conclusions, and future research directions.

2 Basic Notions of Digital Transformation

Digital transformation is investigated from various aspects namely its costs and benefits, available technologies, reliability and vision of realization. In this work, the term will be discussed for companies or researchers wishing to apply customer driven innovation for modeling research and development strategy.

2.1 Digital Transformation Toolkit

Digital transformation manages the right doze for implementing digital technologies to the product life cycle. This paper aims to investigate the convenience of available tools on PLM (Product Lifecycle Management) framework. The available digital transformation tools at today's technological toolkit are classified in 5 sections.

Digital Data Processing Tools: Capturing, processing and analyzing digital data allows better predictions and decisions to be made. Big data proposed as the next frontier for innovation, competition, and productivity at the article [7] to process the information collected from many devices which are becoming crucial to use in our daily life. When it is considered with embedded Artificial Intelligence applications, digital data processing is becoming prominent for companies as a tool of management.

Automation Tools: Automation is another aspect of digital transformation fed by several topics such as robotics and additive manufacturing. Anton Huber, the CEO of Industry Automation Division of Siemens summarizes the process of manufacturing in future factories as follows "You open your PC and you can get your product digitally. You can run it, you can simulate it, and you can manufacture it." Mostly in manufacturing step, human force is reducing. This simultaneously reduces error rates, adds speed and cuts operating costs.

Connectivity Tools: Connection is one of the most important life changers of our century. Ubiquitous sensing enabled by wireless sensor network (WSN) technologies cuts across many areas of modern day living. This offers the ability to measure says Gubbi and Buyya [8] in the article named "Internet of Things (IoT): A vision,

architectural elements, and future directions." Cloud Computing is the model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources [9]. This platform gives the opportunity to benefit from different tools in a common process.

3d Computer Aided Design Tools: Computer-aided design (CAD) is the use of computer systems to aid in the creation, modification, analysis, or optimization of a design [10]. It is fed by several topics such as Augmented Reality and Virtual Reality. Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. By contrast, Virtual Reality (VR) replaces the real world with a simulated one [11].

Digital Customer Access Tools: The (mobile) internet gives new intermediaries direct access to customers to whom they can offer full transparency and new kinds of services using Social Network platforms. It gives companies the opportunity to create competitive advantage through Online Services.

2.2 Market Trends and Customer Demands

Companies are challenged to keep their current position as well as growing. To tackle this challenge, they have to provide a close relationship with their customer segments. Customer-driven innovation [12] requires continuous market research. In addition, customers are always influenced by global social concepts. Below, present customer trends which are going to be used further at the decision model are provided.

Personalization Trend: Personalization is the ability to proactively tailor products and product purchasing experiences to tastes of individual consumers based upon their personal and preference information [13]. It requires, in manufacturing, smaller batch sizes. Companies should launch either a variety of products to catch the attention or products with adaptable design features.

Environmental Awareness Trend: Sustainable development has become a central issue since recognition of the threats to the environment of unregulated economic growth. This trend has started from policy makers. Its influences on customer side have realized as the promotion of organic, healthy materials in product life cycle as well as reduced energy consumption while production and services of the product.

Timelessness Trend: Timelessness has always been important in delivering great service. But lately the timeline of customer expectations in general have sped up to a radical pace [14]. It means to sustain reduced lead-time and easy purchasing options for companies. The same trend promotes online services which requires companies to online presence.

Technological Demand Trend: Today's customer is deeply interested in new technological development. Therefore, they want to find immediately its benefits on their products. It requires companies to make upgrades on products as well as having much more complex designs of products.

Availability Trend: As an influence of the globalization on market trends, customer wants to be able to easily get the product. Company should have the infrastructure for internet channels and moreover an extended market separation including international distribution channels.

Well Branding Trend: Currently, a company which offers a product doesn't sell only its product, customers are expecting more such as an attached meaning. "Conspicuous consumption has given way to more conscious or practical consumerism" and "rampant deal-seeking is being replaced by more purchase selectivity." Another study shows that 87% of consumers in the United States believe that companies should value the interests of society [14]. As it can be realized from Apple example, well-designed products create their own hooligans which are having a deep loyalty to the company.

Responsiveness and Proactivity Trend: The study of consumer habits confirms that shoppers are becoming "more deliberate and purposeful" in their purchasing decisions [15]. Therefore, companies should give priority to customer intimacy to better understand the real demand. A robust and flexible infrastructure is also essential to realize faster innovation.

Basic Expectations: Beside temporary expectations reduced price and increased quality are always promoted from customer perspective.

2.3 Company Processes

Companies have various processes to launch and manage their products such as design, manufacturing, distribution, customer, end of life. It finds place in academics as PLM framework [16]. In this section, the point of view of the further application in the term of sub-topics of each process will be provided.

Design: Design is the first step of product launch process starts by market research which gathers

information about target markets or customers. It is a very important component of business strategy [17]. It is followed by technical research, applied research oriented toward engineering disciplines and aimed at developing tools and test equipment and procedures, and at providing solutions to specific technical problems.

Product development, the creation of products starts with new or different characteristics that offer new or additional benefits to the customer, a prototype is an early sample, model, or release of a product built to test a concept or process or to act as a thing to be replicated or learned from [18]. Design process finishes with testing which is measuring product's performance, safety, quality, and compliance with established standards [19].

Manufacturing: In manufacturing step, companies are supposed to make decisions in various topics which starts by facility distribution, regarding that the design of the distribution system is a strategic issue for supply chain management of almost every company [20].

The process in the factory starts with process design, the activity of determining the workflow, equipment needs, and implementation requirements for a particular process. Process design typically uses a number of tools including flowcharting, process simulation software, and scale models. When the manufacturing process is designed, production starts but questions are coming immediately: How many? Forecasting is the planning tool that helps production management in its attempts to cope with the uncertainty of the future, relying mainly on data from the past and present and analysis of trends.

Manufacturing operations management (MOM) is a methodology for viewing an end-to-end manufacturing process to optimize the efficiency. Maintenance management is another crucial of this section to conduct continuous production. It is administrative, financial, and technical framework for assessing and planning maintenance operations on a scheduled basis.

Distribution: After manufacturing, product is ready to meet up with the customer, distribution is the process which includes marketing, sales and logistics activities of the real product. Marketing management is the organizational discipline which focuses on the practical application of marketing orientation, techniques and methods inside enterprises and organizations and on the management of a firm's marketing resources and activities. It is followed by sales management which is focused on the practical application of sales techniques and the management of a firm's sales

operations. Logistics is the last step of this section including planning, execution, and control of the procurement, movement, and stationing of personnel, material, and other resources to achieve the objectives of a campaign, plan, project, or strategy.

Customer: The main target of a product is to be reached to its customers. Company-customer relationship doesn't finish after sale, companies are required to supply product related services to keep customer loyalty. Customer data collection is the process of gathering and measuring information on targeted variables in an established systematic fashion, which then enables one to answer relevant questions and evaluate outcomes. After-sale services includes several topics such as maintenance, repairing and upgrading.

Customer relationship management is a priority to develop both traditional and new distribution channels, plus media to achieve this in a consistent and coherent way [21].

End of life: In PLM methodology, this step can be defined as "the cyler" of the process. Companies should always be looking to realize a cycled process that will make their product more marketable to their customers as well as for the company to make waste reducing decisions. Recycling is waste minimization strategy in which reusable materials are recovered from a waste stream and put to the original or different use. Re-use is to use an item again after it has been used.

Feedback is the process in which the effect or output of the product is returned to modify the next products, services and launches by improvement process which is the systematic approach to reduction or elimination of waste, rework, and losses in production process and revise the product for further launchings.

3 Proposed Decision Framework

3.1 The Decision Model

The application produces the strategic decision priority which points the most advantageous digitalization tool for the company between available digital transformation toolkit. It can be used by a sector or a company as well as by a manufacturing infrastructure company to shape its road map through the digital transformation of industry. Researchers can benefit from these outputs to choose their potential aspect to focus on. It is the cost-effective decision for the company regarding the limited budget which is shared for innovation activities.

The application requires information of customer demands, company processes and available digitalization tools. Table 1 combines information of customer demands with company processes and produces customer demand score for the relative product life cycle stage. These scores highlight the bottleneck that research and development activities should be focused.

Second step relates digital transformation toolkit with product life cycle stages. Implementing the output of table 1, it sorts tools of digital transformation toolkit for the sector (in our case, automotive sector) by producing a priority list. (Table 2)

On the last line of Table 1, the score for each process step which shows the improvement needs is obtained. These scores are processing together with the information in Table 2 by an if statement to generate the last scores of digital transformation tools in Table 3.

At the result (Table 3), the convenience of available digitalization tools with the sector/company is being calculated. The highest score refers to the most advantageous tool to focus on for the sector or the company.

Table 1: Customer Demand – Company Processes Relevance Matrix

Company Processes			Design					Manufacturing				Distribution			Customer			End of Life				
			Market Research	Technical Research	Product Development	Prototyping	Testing	Facility Distribution	Production Design	Forecasting	Operation Management	Maintenance Management	Marketing Management	Sales Management	Logistics	Data Collection	After-Sale Services	Relationship Management	Recycling	Re-use	Feedback	Improvement
Customer Trends	Relative Actions	Automotive																				
Personalization	Smaller Batch Sizes	3																				
	Variety of Products	4	++	+	++	++	++	+	++	++	++											
	Adaptable Designs	4	++	++	++																	
Environmental Awareness	Organic, Healthy Materials	2	+	++	+	++	++															
	Reduced Energy Consumption	4		++				++	++		++	+										
Timelessness	Reduced Lead-Time	5	+	++	++	+	+	++	++	++	++	++										
	Online Presence	2	+																			
	Easy Purchasing Options	3	+	+																		
Technological Demand	Complex Designs	5	++	++	++	++	++															
	Upgrades on Product	3		++	++	++	++															
Availability	Internet Channels	2																				
	Extended Market Separation	4	++					++														
Well Branding	Attached Meaning	5	++		++																	
	Well-designed Products	5	++	++	++	+	+															
Proactivity	Customer Intimacy	5																				
	Faster Innovation	4	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	++	
	Flexibility	4																				
Basic Expectations	Reduced Price	4		++	++																	
	Increased Quality	3	++	++	++	++	++															
Weights of Signs		Customer Demand Score	114	124	128	73	73	59	60	52	64	31	77	80	76	101	19	133	30	30	106	120
		Reduced Customer Demand Score	7	8	8	5	5	4	4	3	4	2	5	5	5	7	1	9	2	2	7	8

In the application, Table 1 and Table 2, lines and columns are combined by interest signs. These signs are introduced as “++” strong interest counted 3 in calculations as the degree of influence, “+” interest, counted 1 in calculations.

Sector interest values about automotive industry in Table 1 refer to define sector or company

specifics. In example application, the values are set by the author regarding interviews with sale representatives of automotive companies; Toyota, Opel and Mazda, about expectations of their customers. Sensitivity of this section effects the precision of the decision.

Table 2: Digital Transformation Toolkit – Company Processes Relevance Matrix

Digital Transformation Toolkit:			Digital Data		Connectivity		Automation		3d CAD		Digital Customer Access	
PLM	Aspects	Reduced Customer Demand Score	Big Data Applications	Artificial Intelligence	Internet of Things	Cloud Computing	Robotics	Additive Manufacturing	Augmented Reality	Virtual Reality	Social Network	Online Services
Design	Market Research	7	++		+	+					++	
	Technical Research	8		+						+		
	Product Development	8		+							++	
	Prototyping	5			+			++	++			
	Testing	5	+	++						++	++	
Manufacturing	Facility Distribution	4	+		++							++
	Production Design	4	+	++	++	+	++	++	++	++		
	Forecasting	3	++	++	++	++						++
	Operation Management	4	++	++	++	++						++
	Maintenance Management	2	+	++	++		++			++		
Distribution	Marketing Management	5	++	++	+							++
	Sales Management	5	+	+	++							++
	Logistics	5	+	++							+	++
Customer	Data Collection	7	++	++	++	++					++	+
	After-Sale Services	1	+	++	++	++				++	+	+
	Relationship Management	9	+	+	++	+					++	++
End of Life	Recycling	2	+		++	++	++			++		
	Re-use	2	+		++	++	++			++		
	Feedback	7	++	++	++	++					++	+
	Improvement	8	+	+	+				++	++	++	++
Weights of Signs		Score	145	165	173	98	68	51	80	110	163	123
		Percentage	12,37%	14,07%	14,71%	8,31%	5,80%	4,30%	6,77%	9,33%	13,91%	10,43%
		Priority	4	2	1	7	9	10	8	6	3	5

4 Findings and Conclusion

At the result of the example application, the decision model highlights several tools to engage in order to achieve customer-driven innovation. internet of things (IoT) had the highest rank. It means companies in automotive industry should be engaged with IoT and its applications in order to supply present and future customer demands.

Table 3: Results Table

Digital Transformation Toolkit	Focus Percentage	Priority	
Digital Data	Big Data Applications	12,37%	4
	Artificial Intelligence	14,07%	2
Connectivity	Internet of Things	14,71%	1
	Cloud Computing	8,31%	7
Automation	Robotics	5,80%	9
	Additive Manufacturing	4,30%	10
3d CAD	Augmented Reality	6,77%	8
	Virtual Reality	9,33%	6
Digital Customer Access	Social Network	13,91%	3
	E-Commerce	10,43%	5

“Today, cars have become the ultimate connected device.” says Stefan Schumacher, director of Global Automotive Solutions section of IBM [22]. SAP specified consideration priorities for building a successful IoT strategy in automotive industry such as connected cars, connective logistics, predictive maintenance and connected fleet. By the first look, this field of study creates big opportunities for automotive industry as well as challenges that companies should be well positioned to handle. Safety and security are relevant subjects of the topic [23] therefore, Richard Kirk is discussing the future risks of IoT in transport.

Artificial intelligence, big data applications, social network of customers and virtual reality tools are the other crucial tools for the industry. The values of result are approximately separated between %10 and %15 which demonstrates that companies should manage effective innovation activities in the course of time to be engaged in most of the technologies at the toolkit.

Consequently, internet of things is the principal tool of digital transformation which covers present customer demands of the automotive market.

Regarding the result, companies can shape their innovation road map to supply customer demands as customer-driven innovation requires. Researchers can focus more on the topic to fill the gaps in order to push the innovation.

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