Journal of Management, Marketing and Logistics
Year: 2017 Volume: 4 Issue: 3

FROM MASS CUSTOMIZATION TO PRODUCT PERSONALIZATION IN AUTOMOTIVE INDUSTRY: POTENTIALS OF INDUSTRY 4.0

DOI: 10.17261/Pressacademia.2017.486
JMML- V.4-ISS.3-2017(6)-p.244-250

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To cite this document
Kabasakal, I., F.D. Keskin, K. Ventura and H. Soyuer, (2017). From mass customization to product personalization in automative industry: potentials of industry 4.0. Journal of Management, Marketing and Logistics (JMML), V.4, Iss.3, p.244.250.
Permemant link to this document: http://doi.org/10.17261/Pressacademia.2017.486

ABSTRACT

Purpose- Industry 4.0 involves a paradigm shift in marketing management as well as operations management. The recent literature identifies a transformation from mass customization to mass personalization. The purpose of this study is to explore the transformation addressing the Industry 4.0 concepts and recent progress in the automotive industry.

Methodology- This study is an exploratory research utilizing case study method. Interviews were carried out with one of the leading automotive brands. Data were analyzed through descriptive analysis.

Findings- The case study identifies the product decisions with a focus on customization and personalization themes. Customers' involvement in design process is emphasized as well as customer data for a more customer-oriented strategy. The findings suggest that disruptive technologies provide a basis for mass-personalization strategy.

Conclusion- Our case study demonstrates that automotive industry is one of the leading industries that prioritize customer preferences. The customization is achieved through numerous options supported by generic architectures. Nevertheless, personalization represents a higher degree of one-to-one marketing vision. Industry 4.0 contributes to such vision with emerging technologies that facilitate collection and analysis of customer and provide more personalized experience.

Keywords: Industry 4.0, customization, personalization, automotive industry.
JEL Codes: L62, M11, M31

1. INTRODUCTION

New market conditions and recent developments of information and Internet technologies have had transforming effects on the business environment. Technological advancements, especially introduction of cyber-physical systems (CPS) and the internet of things (IoT) into the manufacturing environment has ushered in a new industrial vision, Industry 4.0 (Weyer et al., 2015). CPS includes intelligent machines, storage systems, and production facilities enabling to exchange information with autonomy, trigger actions and control each other independently (Posada et al., 2015). Such technologies provide a basis to create new forms of interaction among the customers and firms. With the technologies that provide a basis for Industry 4.0 concept, a business environment integrating physical objects, machines, information, and human is configured. Brettel et al. (2014) underlined that manufacturing systems support reconfiguration in today's smart factories, where configuration rules can derive distinct topologies.

Industry 4.0 is a comprehensive approach affecting all business processes, as distinct from all previous industrial revolutions that have focused on production processes and had significant effects on shop floor level (Schuh et al., 2014). It allows incorporation of individual, customer-specific criteria into the design, configuration, ordering, planning, manufacturing and operation phases. It has the potential to meet individual customer needs that even one-off items can be manufactured profitably (Kagermann, Wahlster, and Helbig, 2013).

Industry 4.0 that promises to transform the existing business models with its enabling technologies, also leads new opportunities in marketing strategy. Customer preferences have become more prominent in product configuration due to mass customization. In the past few decades, manufacturing paradigm has evolved to respond to the market. In the next section, a summary of progress in manufacturing along with mass customization will be summarized, and the differences between mass customization and personalization will be argued.

2. LITERATURE REVIEW

Industry 4.0 will potentially enable smaller lot sizes in production, providing a more customer oriented approach in product design. Ideally, one-lot size production is expected to be feasible soon in many manufacturing environments. In this part, the importance of modular architecture and configuration is explained at first. Subsequently, the transformation from mass customization through personalization is discussed.

2.1. Modular Architecture and Configuration

In the last few decades, rapidly globalizing market forced manufacturers to differentiate their products by focusing more on customer needs and shift their manufacturing paradigm from mass production to mass customization (Sabin & Weigel, 1998). Thus, the primary objective in mass customization can be summarized as to achieve flexibility as well as efficiency in manufacturing. For such purpose, the key solution was in modular, generic product architecture.

Dahmus et al. (2001) defined the product architecture as a key activity in industrial product development activity. It has been claimed that successful product architecture facilitates addressing the variance from customer to customer or segment to segment. Besides, the study attaches importance on the product architecture with swappable parts on standard interfaces, since such designs enable new product offerings to product owners even after the purchase. To respond to the variety of customer requirements, such an approach in product design enables customization with alternative components with compatible interfaces. In this perspective, the configuration is described as a task that includes selecting a combination of parts to find a valid and complete product structure within the alternatives of generic architecture (Sabin & Weigel, 1998).

Within a generic architecture, product configuration is about the selection of parts to meet the requirements defined by customer demand. In this aspect, Aldanondo and Vareilles (2008) described the configuration term as a task that includes finding at least one set of components that satisfies customer requirements as well as constraints. From this perspective, product configuration is both important for requirement configuration in marketing management and process configuration in manufacturing management.

Gershenson et al. (1999) described redesign as a challenging and costly operation since it requires engineering analysis; on the other hand, reconfiguration is characterized as a cost-effective activity that increases the relative modularity. Dahmus et al. (2001) expressed that the leading automobile manufacturers such as Volkswagen and Ford take advantage of platform and component commonality, and effectively differentiate their products based on the customer needs.

2.2. Mass Customization vs. Personalization

Mass customization can be briefly defined as a strategy based on the ability to provide customized products/services through flexible processes to differentiate in highly competitive markets (Da Silveira et al., 2001). In terms of manufacturing management, it relates to flexible manufacturing and product architectures. Product architecture design along with product configuration is an essential approach that enables more options to customers and helps to differentiate on the market. Furthermore, mass customization is also related to the market orientation as well as manufacturing.

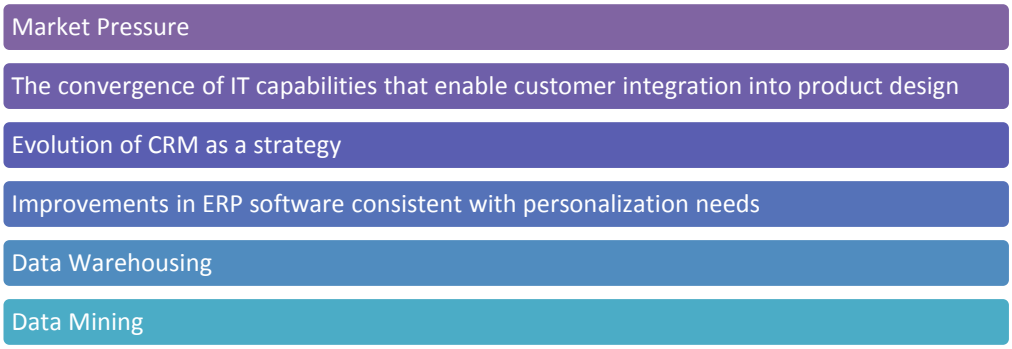
A more customer-oriented implication of mass customization leads to increasing count of products along with various options that successfully capture the needs and tastes of customers. Personalization and customization have a significant role for this purpose. Although it can be claimed that both approaches point to an identical goal in a manufacturing perspective, they can be differentiated in the origin of customer requirements. Customization is mostly described as an arrangement of product with options required by the customer. On the other hand, personalization refers to the adaptation of products and services by the producer based on the customer information deduced from consumer's behavior (Montgomery and Smith, 2009).

Gilmore and Pine (1997) identified four approaches (collaborative, adaptive, cosmetic and transparent) for customization that respond to customer needs. Among the cost-effective models identified, they pointed out that mass customization is mostly associated with the 'collaborative approach'. In the collaborative approach, the customer needs are articulated by firms and products are designed with appropriate options in accordance. On the other hand, the 'transparent approach' in customization requires the customizer to observe customer behaviors over time, looking for predictable preferences (Gilmore and Pine, 1997).

Arora et al. (2008) distinguished personalization and customization regarding the party that initiates the process: personalization is firm initiated whereas customization is customer initiated. In such a perspective, customization can be attributed to an action initiated by the customer, namely customer choice. A customer might review the alternative products and options provided and ask for customization to select a product of his/her preferences. Personalization, on the other hand, is mostly achieved through information technology to collect and analyze customer data. Moreover, personalization is about achieving each customer satisfaction individually, whereas the customers are classified into different market segments, and customers within the same segment receive parameter-based customized products in customization (Tseng et al., 2010).

Kumar (2007) argued that there is a strategic transformation from mass customization to mass personalization; however, the degree of the transformation varies across industries. According to this perspective, the factors that facilitate mass personalization are defined as in Figure 1.

Figure 1. The Factors that Facilitate the Transformation from Mass Customization to Mass Personalization



Source: Adapted from Kumar (2007)

3. DATA AND METHODOLOGY

The purpose of this study is to reveal the transformation towards product configuration in today's automotive industry, and explore the conformance of product strategies and demonstrate the personalization activities of BMW brand within a case study. Case study as a research method allows understanding events in-depth (Fidel, 1984) and involves exploring the conceptual structure of events by focusing on a particular topic (Yin, 2011).

In the present study, case study covers the practices of BMW, which is one of the leading automotive brand in premium car segment, adopting Industry 4.0 operations. The research questions are as follows:

- What are the developments in automotive industry within Industry 4.0?
- How will the automobiles be personalized?
- How will be the personalization offers of BMW in the future?
- How will the Industry 4.0 contribute to product configuration of BMWs?

To collect data, many interviews were carried out with the general manager and senior executive of Ozgorkey Automotive, which is the authorized agent of Borusan Otomotiv İthalat and Borusan Otomotiv Pazarlama. Furthermore, secondary data sources consisting of the documents and reports obtained from the case study firm were examined. Structured interview technique was used for identifying and exploring the product configuration and personalization activities. Among the purposive sampling techniques, "typical case sampling" method was used for the study. To reveal a new application, typical case sampling method requires the examination of one or more typical samples (Yıldırım and Şimşek, 2008).

Interviews lasted 45 to 60 minutes. In this paper, the participants' statements are given as quotations to make them clear to readers. To increase the validity of the study, the data obtained from the interviews were explained and reported in

detail. To increase its reliability, the interview notes were reviewed by Ozgorkey executives, who made appropriate corrections through their reviews.

The data were analyzed through descriptive analysis method. First, the themes under which the data would be evaluated were determined based on the conceptual framework, and the interview notes were organized under the themes determined. Then such data were supported by direct quotations. A coding sheet was created. The coding sheet involved various key codes such as "product configuration" and "personalization". Lastly, all the interview notes were read, and the statements concerning each view were coded on the coding sheet prepared for the interview.

4. FINDINGS AND DISCUSSIONS

The industrial production of high-tech products such as automobiles has to be leveraged between the satisfaction of various customer needs through personalization and the realization of scale effects. This dilemma between the economies of scale and personalized needs can be addressed by the concept of Mass Customization (Fogliatto, da Silveira, and Borenstein, 2012). The increased importance of mass customization leads to important changes in the product configuration (Brettel et al., 2014).

Customization & Personalization in Automotive Industry: Current Situation vs. Future Perspective

According to the McKinsey (2016) diverse mobility, autonomous driving, electrification, and connectivity are projected to be the primary forces that cause disruptive changes in the automotive industry. In addition, the report credits the predictions on consumers' new habit of using tailored solutions in the near future and emphasizes the change in consumer preferences along with technological breakthroughs. It can be argued that last industry revolution, namely Industry 4.0, will reinforce the convergence of connectivity, electrification, and changing customer needs.

For 100 years, the industry has relied on vehicles that are stand-alone, mechanically controlled and petroleum-fueled. However, with the new revolution, interconnected, electronically controlled and automobiles fueled by a range of energy sources will dominate the industry (World Economic Forum, 2016). The developments mentioned fortifies the McKinsey report, which stresses the transformative aspect of technology. The statements of a senior executive of Ozgorkey on this matter are given below (Executive Committee Member, Ozgorkey):

> *"When the Kyoto Protocol comes into effect, the automobiles running on fossil fuels will begin to decline all over the globe. All new cars in Germany and Denmark will be emissions-free at 2030, both governments are taking steps to forbid the fossil fuels. They expressed that non-pure hybrid automobiles will be on the way..."*
>
> *"... let me reveal some of the examples that will show up with Industry 4.0: Haval, a Chinese-Australian joint-venture will make drone cars. An integrated drone attached to the cars will help shopping: drones will be able to buy and retrieve the products; for instance, those in your last shopping list; then mount onto the car at the end...."*
>
> *".... There is a company with American and Italian partners: 'Next'. They predict that automobiles such as electric wagons will become widespread in the future. Imagine such wagons with advanced rechargeable battery technology. You might ask the car through your mobile phone to drive somewhere, either with other people to socialize, or alone for tranquility. The wagon mounts to other wagons to save energy and dismounts whenever needed, helping to reduce traffic by 75% and drop fuel consumption by 35%...."*

According to statements above, there is a disruptive and transforming progress en route in the automotive industry. However, the demand in the market is far beyond the promising innovations of mechanics, and the manufacturing technology is challenged by the customer expectations that diversify more than ever. Hu (2013) pointed out that in today's flexible and reconfigurable manufacturing systems, high variety in the final assembly is created through the combinational assembly to achieve the economies of scale; and argued that the consumer has a limited role when choosing the module combinations instead of obtaining exactly product he/she desires. However, with the emerging technological disruptions, consumers' willingness to be involved in product design becomes the key driver of emerging manufacturing paradigm, which is called personalization (Hu, 2013).

Arora et al. (2008) claimed that customization is applied in a variety of industries including the automotive industry; moreover, the strategic advantage offered by customization is greater where product differentiation is hard but crucial. In this perspective, it is lucid that auto industry equips car models with numerous customization options. Specifically, the emergence of 3D printing contributes the personalization as a promising strategy to achieve the market-of-one vision (Yao and Lin, 2015). In our case study, the importance of 3D printing technology and prototypes are also mentioned by the firm executives as well. The future trends of personalization are summarized as follows (Executive Committee Member, Ozgorkey, Ozgorkey):

> *"... 3D, 4D, even 5D models of the automobiles will be used to achieve a higher degree of customization. The design of the car can be obtained from the customer, the customer also can choose the engine, and then a prototype can be built. Ordering the parts required for the prototype is the next step to be carried out..."*

It is reasonable to conclude that the statement complies with customization at first glance since it implies that the customer has the initiative in customization. Arora et al. (2008) emphasized that the party who initiates the process is decisive to distinguish customization and personalization. On the other hand, the statement also complies with the definition of personalization by Montgomery and Smith (2009). Customers are actively involved in the design process; thus, the role of the customer is more than "an arrangement of options" offered to him/her. Moreover, it can be argued that the role of the customer is being extended as a co-designer, beyond an ordinary customer.

Customization & Personalization in BMW: Current Situation vs. Future Perspective

In the light of the developments mentioned, BMW, one of the leading premium car manufacturers, customizes the cars with various options to respond to the customer expectations. According to the statements made in the interviews, the customer data collected by the CRM system is obtained from two primary sources: service records and data recorded on BMW's "KeyReader" devices. Service records involve customer opinions, such as complaints or requests. Such information sometimes provides useful user feedback on product configuration. Furthermore, KeyReader device, introduced by BMW, autonomously keeps track of the timing of service visits and maintenance requirements. The quality of the fuel consumed is also monitored by the system. As the representative verbalized, fuel quality is mostly analyzed by mass-premium automotive producers. The engines offered across the regions often vary regarding the European Emission Standards. In the interviews, it was also mentioned that the analysis of the fuel quality is decisive on the variety of engines provided for a country.

The device also automatically analyzes the usage statistics of the driver and logs the patterns matched by the analysis. The general manager expressed that the KeyReader technology can record data about the driving dynamics captured from the actions of the customer. For example, the system can calculate the count and the duration of brakes. In service visits, the statistical data logged by KeyReader device is transmitted to a global database in the global HQ. As the participant remarked, the database is analyzed by the engineers when the parts of the car are designed. Besides, geographic data is also taken into consideration in the analysis. In this regard, it is clear that the technical data collected from existing customers are analyzed in product development. Moreover, the geographical analysis is useful when customizing the product line across countries.

Another important customization tool remarked in the interview is the "ConnectedDrive" technology. This technology is integrated into the car by a platform enables a wider range of features. A timesaving feature helps the owner when a target location and time is shared with the car. In particular, the navigation system built within ConnectedDrive can calculate when to set out and notify the owner. Moreover, the navigation system remembers the address when the driver gets into the car. Integrated services provided by the software assists the owner outside the car as well. The ConnectedDrive software also can learn the owner's frequent routine destinations. When there is an accident or a traffic jam on the daily route, the owner is notified to help saving time.

Revisiting the debate on the customization and the personalization, the cases explained demonstrate a case where a mere definition of "customization" or "personalization" is inadequate. As mentioned earlier; personalization is mostly associated with situations including analysis based on customer data (Arora et al, 200). Additionally, the personalization is used for one-to-one targeting rather than targeting the segments as in customization. The KeyReader technology logs data about the drivers' regular usage, including a potential for insight on a more personal level. However, the products developed including numerous customizations are targeted through the masses. Within the context of new industrial revolution, disruptive developments are expected for the personalization of BMWs. The statements of a senior executive of Ozgorkey on this matter are given below (Executive Committee Member, Ozgorkey)

> *".... In BMW's plans, Vison Next 100 represents the future of BMW cars.... The car is totally custom-tailored and equipped accordingly. Today, using the smart key technology, a customer can park his/her car (remotely); the smart key tells the customer where the car is parked. In 7-series and 6-series, the system works as this way. The next versions are powered by Apple's software; the voice control feature works seamlessly, for instance I might tell the software to order and deliver a 13-carat diamond for my wife.... I will also be able to use the car as a well-equipped office. The car will help me to order from a grocery store, help me in hotel transfers and so on. Autonomous driving will get prevalent after 2020, the system will handle driving and you will have the opportunity to rest.... It takes up to 4 months in total to make a completely custom-tailored car, transport from Germany and deliver to the owner..."*

The design of Vison Next 100 accommodates innovative technologies such as autonomous driving, augmented reality. The vision car will provide dynamic and regenerating features that even help to adjust the car for the best driver experience on every drive. The smart features mentioned can be qualified as a high-level personalized car. According to the statements in the interviews, BMW offers virtually unlimited individualization for custom orders. The mobile application 'BMW Individual' helps to explore various options for paint finishes, interior trim, and equipment. The customization options offer numerous color and style options for interior and exterior of the car. Furthermore, textures used in wood and leather decorations can be customized. It is even possible to include owner's signature in the interior design of the car. Essentially, premium brands mostly offer such customization options in different ways for a long time. However, it can be argued that BMW individual vision respects BMW customers as a co-designer through the mobile applications powered by augmented reality technology. To summarize, it has been noticed that smart and innovative customization practices in BMW represent the characteristics of personalization theme; particularly those enabled through data analysis and customer-driven design.

5. CONCLUSION

In the study, the Industry 4.0 phenomenon is discussed with a focus on the themes of customization and personalization. Technological developments have transforming effects on manufacturing and marketing vision in the automotive industry. Mass customization reflects the alignment of manufacturing environment into a more customer-oriented stance in the last decades. The manufacturers offer more and more options for customization; however, the rapid transformation along with Industry 4.0 pushes today's automotive industry to a more personalized level of product development. With an emphasis on the distinction of customization and personalization, the primary objective was to reveal the importance of product configuration and to explore the conformance of product strategies in the automotive industry. From this point of view, we carried out interviews with BMW, one of the leading automotive brands in premium car segment.

The findings from the literature review and interviews have been conducted to reveal the trends in one-to-one level marketing efforts. The statements provided by BMW executives suggest that the variety of options supplied to the market are booming along with technological progress. Within the context of Industry 4.0 transformation, the innovative progress has been discussed along with major developments in technology attributed with Industry 4.0. One of the major findings of the study is that automotive industry has put an emphasis on mass customization towards a more personalized marketing vision in the previous decades. Moreover, the interviews revealed the fact that automotive industry is heavily influenced by recent technological progress, such as mobile technology, data mining, 3D printing, and sensors. However, the distinction between mass customization and mass personalization discussed in related literature was not directly addressed in the statements provided by firm executives. Therefore, to provide a basis for further argument, with the terms addressed in mass customization and mass personalization discrimination; the statements were evaluated and discussed regarding the important concepts and discussions in the literature review.

The product policies related to customization can be expressed by the variety of the vehicles and the options provided by manufacturers. The options include different aspects of the product including the technological and cosmetic variations. Moreover, technical variations of automobiles including various engine technologies are offered to the market. As the research suggests, the mass customization strategy is applied to achieve both cost reduction and customer satisfaction. However; as discussed in the literature review, the mass personalization strategy promises a higher level to achieve one-to-one marketing while taking advantage of the economies of scale. For this reason, the statements that imply the efforts relating to personalization concept were also emphasized in the discussion. The findings on this issue are mostly related to product design. In particular, customer data collected through KeyReader technology are collected and mined to provide more personalized offers to customers. Moreover, data primarily intended for maintenance is also analyzed to improve product design process in the automotive industry. From this point of view, it can be concluded that customer data involving locations visited, active hours provide more opportunities for personalization. Moreover, the mobile technologies integrated into automobiles, Apple Car in particular in BMW, offers numerous applications that consume such data and help to create a more personalized experience. The findings of the study also suggest that the role of customers is converging to a step that was defined as "co-designer." Moreover, our case complies with Hu's (2013) assertion that emphasizes consumer participation as a crucial element in the emerging manufacturing paradigm. Prototypes powered by 3D printing technology and virtual reality are critical to enable such level of personalization.

In conclusion, the findings of the case study suggest that automotive industry effectively employs mass customization. However, personalization represents a higher degree of one-to-one marketing vision. In particular, the firm examined in our case prioritizes personalization activities to create more customer value and develop a more customer-oriented product design approach. Besides, the disruptive progress along with Industry 4.0 comes up with various opportunities to facilitate the mass-personalization strategy. It can be concluded that the new Industry Revolution both requires and provides the personalization movement in the automotive industry.

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