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SMART SOLUTION FOR OPTIMIZED MASS CUSTOMIZATION PROCESS IN SMART PHONE INDUSTRY

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Abstract

The concept of mass customization envisages a firm pursuing differentiation vis-à-vis its competitors in the form of its customized solutions to the consumers, and at the same time adopting *cost-effective measures to bring down the cost of production of those solutions. Mass customization has proved to be a path-breaking approach in many industries like fashion, footwear and computer. In this paper, we aim to cover the possibilities of mass customization in the smartphone industry at the hardware, software as well as OS level. We will also cover how, by implementing mass customization, smartphone companies can save costs of finished goods inventories, and at the same time, increase consumers' willingness to pay by providing them with customized solutions. This paper proposes a smart solution for implementing mass customization through mathematical formulation and aims to detect the optimized groups and cost estimation.*

Keywords

Mass Customization, Smart Phones, Mass Production, Customization, Make-To-Order (MTO), Economies of Scale (EOS), SMOTE Algorithm

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1. Introduction to Mass Customization

"*Mass customization's goal is to provide enough variety in products and services so that nearly everyone finds exactly what they want at a reasonable price."* (Pine, 1993)

"Mass customization is the process of combining cost-saving effectiveness of mass production with the value-added processes associated with product customization." (Duray, 2002)

"Mass customization is the ability to manufacture a relatively high volume of different product options for a relatively large market that demands customization, without substantial tradeoffs in cost, delivery and quality." (McCarthy, 2004)

In all the definitions of mass customization stated above, one theme stands common – mass customization is not only about customizing according to the consumers' needs, but one also has to leverage the economies of the mass production system. This aspect busts the long-standing myth that firms need to adopt either differentiation or cost leadership strategies for achieving competitive advantage. The concept of mass customization envisages a firm pursuing differentiation vis-à-vis its competitors in the form of its customized solutions to the consumers, and at the same time adopting cost-effective measures to bring down the cost of production of those solutions. Pursuing both strategies at the same time requires leveraging capabilities and competencies (sets of interlinked capabilities) in the firm to achieve this unconventional feat. The implementation of mass customization provides a firm with a sustainable competitive advantage over its competitors because the capabilities required for implementing a mass customization approach are difficult to imitate or replicate.

2. Need for Mass Customization in Smartphone Industry

"Innovation" is a buzzword these days that echoes very frequently in Smartphone industries which are high on the technological front. In their quest to innovate at a pace faster than their competitors, Smartphone manufacturers are increasingly providing more and more functionalities to their customers, hence, adding to the versatility of the phones. The increasing versatility leads to increased costs of manufacturing which are passed down to customers in form of increased prices. For the Smartphone giants, this means that every newly launched product is about 10~20% more expensive than the previous one. However, the customers may not desire all of the new innovative features that have been included by the manufacturer. E.g., the hardware configuration available in the market may have 6GB RAM, 64GB ROM, 6 inches screen in dimension and four cameras with high resolution. There may be a group of customers who wish to have the above configurations except for the high-resolution cameras. Similarly, there may be a group of camera-loving customers who might not necessarily want a lot of sensors in their phones.

Furthermore, different segments of users may be having different preferences for the applications on their phones. E.g., some users, who are purchasing a phone only for basic purposes like calling and messaging may not be finding the social applications to be of any use to them. Similarly, users who are extremely passionate about gaming may feel delighted if the phone has a lot of popular games already installed for them, and may be willing to pay a premium for it.

This is where mass customization in the Smartphone industry can prove to be a very useful approach.

3. Selecting the Mass Customization Model

Before starting with mass customization in any organization, it is essential to identify which model/approach to mass customization will be most suited to the industry in which the company is operating. In general, Make-To-Order (MTO) process is said to be a must to implement for any firm which is pursuing mass customization (in contrast to the Make-To-Stock process approach). This is required to fulfil individual customer orders while achieving production economies (lean and JIT inventories) simultaneously – together the two strategies lead to the effective implementation of mass customization concepts. However, Make-To-Order involves starting everything from scratch after the order is received from the customers, which renders this strategy unsuited for certain industries which have complex technological end products, that have many sophisticated and interdependent modules and components.

For industries with such characteristics, alternatives such as Engineer-To-Order (ETO) and Assemble-To-Order (ATO) have been suggested (Slack et. al.,1998). In ETO, the engineering of components and sub-assemblies begins after the order has been received, but the raw material purchase is done beforehand. In ATO, the components and sub-assemblies are engineered and kept ready. The assembly of these components and parts begin once the order from the customer has been received.

In the Smartphone industry, the end products are made up of many sophisticated and interdependent modules and hardware components such as display screens, processors, memory units, cameras, sensors, and so on. Manufacturing is dependent on a lot of players in other industries for parts and supplies.

In such conditions, the Assemble-To-Order approach (ATO) (Figure 1) is most suitable to implement mass customization. In ATO, the components and sub-assemblies are engineered and kept ready. The assembly of these components and parts begin once the order from the customer has been received and the components that will be used in the assembly depending on the configuration that the customer has selected for the product from the available set of possible configurations offered through a manual or web catalogue.

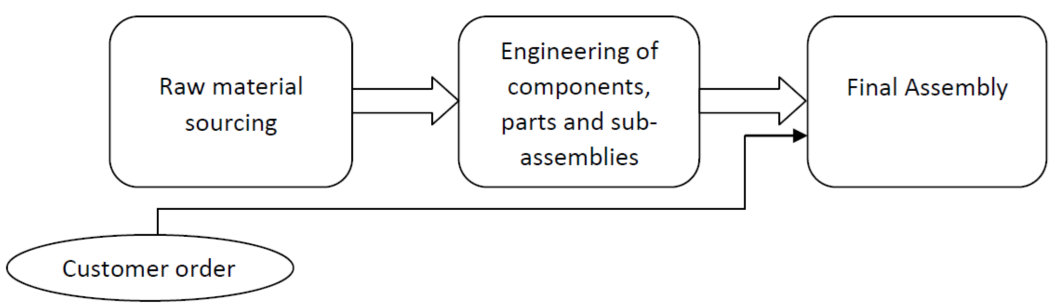

Figure 1: *Assemble-To-Order*

(Source: ATO)

Similarly, the catalogue may provide options to choose from for customizations of software as well. Smartphone companies engage in customizing the applications, changing their looks/designs and adding extra features. The firm may also choose to install all the phones with the standard version initially. Once the demand for a customized operating system is placed, the same can be done at a later stage in the production process (Figure 2).

The concept of modularization can be implemented by the firm to provide the applications pre-downloaded in the phones based on the application-category preference, specified by the customer while placing an order on the website. The application may include categories like business, games, finance, health, lifestyle, education etc.

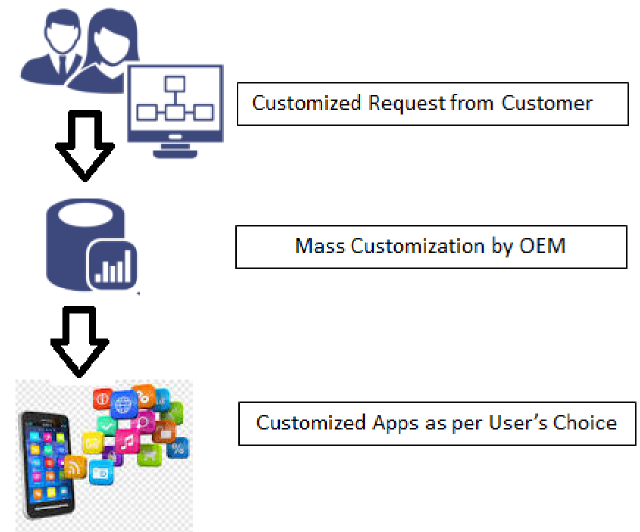

Figure 2: *Modularization*

(Source: Self)

For each of these categories, the firm should be maintaining a list comprising the top 5 or 10 applications under the respective categories, which can be determined based on market research. On selecting a particular category, the customer's phone would be pre-downloaded with the respective list of applications and in return, the firm can ask for premium payment from a customer in return for a customized solution. This is an organic way of generating additional revenues for the firm. Yet another method is by going the inorganic way and allowing the application developers to bid for the top slots in the company's category sets. The topmost 5 or 10 bidders would be pre-downloaded in the phones of the customers. The same model can be adopted for offering customers the choice of having pre-installed movies, games, videos, songs, books and many more software components.

4. Workflow Methodology

The proposed solution to apply Mass Customization in the Smartphone industry has been divided into 3 Phases:

Phase 1: Smart Identification of Usability Features

Phase 2: Optimized solution of '*Similar but Not Same'* Usability Features and Detection of Aesthetic Features

Phase 3: Predicting demand of each possible feature set

5. Mathematical Framework for Applying Mass Customization

Phase 1: Smart Identification of Usability Features

Let's suppose, there are 'm' number of hardware components and 'n' number of software components that can be customized, represented as:

$H_1 \mid H_2 \mid H_3$ …………… H_m, and

$S_1 \mid S_2 \mid S_3$ ……… S_n

The possible combinations of customer choices may range from 1 to X for hardware components and 1 to Y for software components, where,

$X = {}^{m}C_1 + {}^{m}C_2 + {}^{m}C_3 + \ldots\ldots + {}^{m}C_m$

$Y = {}^{n}C_1 + {}^{n}C_2 + {}^{n}C_3 + \ldots\ldots + {}^{n}C_n$

But not all combinations of configurations are technically feasible to offer to the end users. E.g., if the customer chooses device storage to be 128GB, it may be technically mandatory to choose RAM of at least 6GB for stability and efficiency of the phone. And to enforce this, the OEM may decide to disable the lower RAM options under the RAM selection category. Similarly, if the customer selects high pixel resolutions rear and front cameras as customizations and a low RAM option, the requirements might be contrasting.

Determining the valid combinations manually is a difficult task. Hence a smart solution needs to be applied to decide these combinations. This smart solution takes all possible combinations of hardware and software components as a feed, along with the constraints, and gives out a 'k' number of feasible combinations, where $k << (X + Y)$ (Figure 3).

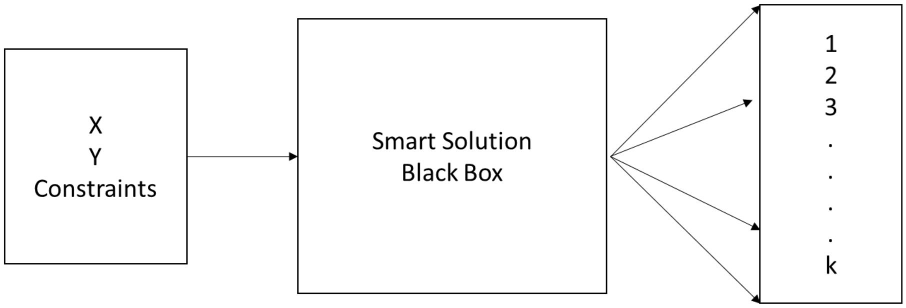

Figure 3: *Generating Feasible Combinations Out of All Possible Combinations and Constraints*

(Source: Self)

The constraints consist of combinations of configurations which should always occur together. E.g., if H_2 is selected, it must always be accompanied by H_3 and S_1.

These combinations selected by smart solution need to be pre-engineered and tested before uploading them in the catalogue.

Phase 2: Features and Detection of Aesthetic Features

After identifying the feasible combinations, we will put similar preferences of customers into similar clusters to achieve cost reduction and optimization (Figure 4).

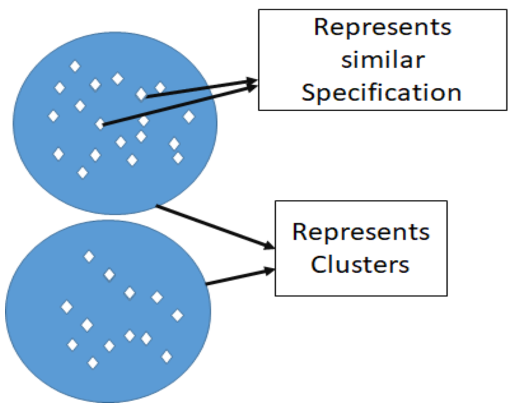

Figure 4: *Cluster Formation Of "Similar but Not Same" Customers*

(Source: Self)

Each cluster has a set of similar but not the same data points. The distance between similar points in a cluster is generated by the aesthetic features of a Smartphone, which may act as a delight factor for a certain set of customers. Examples of such aesthetic features are the color and material of the back cover, the addition of tempered glass, accessories like earphones or earbuds etc.

Phase 3: Predicting Demand of Each Possible Feature Set

The next step is to predict the demand for each possible feature set, so that the Smartphone OEM may strategically plan and execute the process of assembly of the features, based on orders placed by a sample of customers. However, for some clusters, the sample size may be extremely small as compared to other clusters. To overcome this and predict demand accurately, we fill each cluster by using SMOTE algorithm (Chawla et. al., 2002), so that each cluster has the same number of elements, i.e.

$C_i + P_i = C_j + P_j$, where,

C_i & C_j are clusters belonging to 1 to k (identified in Phase 1). P_i and P_j are augmentation factors after applying SMOTE algorithm.

Next, to determine the demand based on historical purchases from the sample set of clusters formed above, let's assume the historical demand from the feature set was X. Also, let's assume that the OEM has projected sales of Smartphones to be increased by a factor of S based on the industry growth trend. Then,

Current year's overall demand = [(100 + S) /100] * X

Hence the demand of each cluster can be estimated by

$[(C_i + P_i) / \sum_{i=1}^{n} Ki\ ] * [(100 + S) /100] * X$

6. Sourcing and Distribution Aspects

The "mass" aspect of the mass customization concept is one of the keys to achieving economies in the entire process. These economies are based on scale. The modular approach discussed above can help in reaping the benefits of economies of scale, wherein the modules/components can be manufactured by the firm in mass or can be sourced from a third party in bulk (and hence get entitled to a volume discount) which in turn would manufacture the components in large volumes. This may require some adjustments to the engineering and design of the components to make them suitable for a diverse number of end products (Figure 5). In the traditional approach, module X would be manufactured by a third-party firm to be supplied to Firm A for use in end product P1. It would also be manufacturing a module Y, which would be supplied to Firm B (supposedly in the same or similar industry to Firm A) for use in end product P2. A new approach suitable for enabling mass customization to be successful would be to reconfigure the modules and produce a module Z which could be used both by firms A and B in their respective end products with little or no modifications at all (Mikkola, & Larsen, 2004). This transition in approaches is shown below.

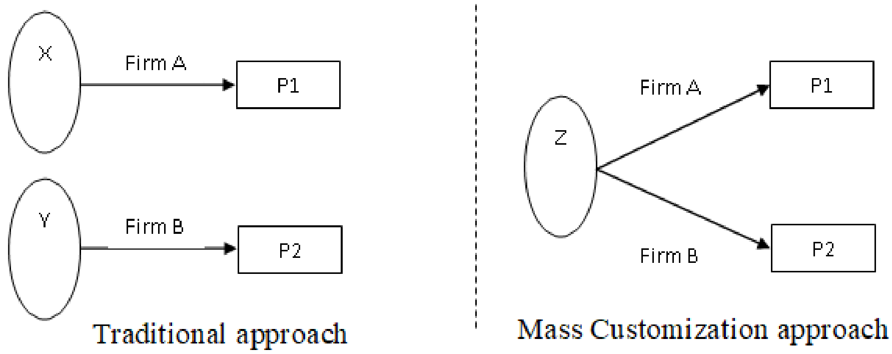

Figure 5: *Sourcing Approaches*

(Source: Self)

Apart from the modularization approach which injects economies of scale into the entire customization system, there are other value chain factors which if managed efficiently, can bring economies of scope to the system. The most important of these factors is supply chain distribution. The distribution process that is well suited for the firms pursuing mass customization is referred to as Mass customized distribution (Mason & Lalwani, 2008). This is highly relevant to the successful implementation of mass customization because the need is to provide more efficient, more flexible and customer-efficient distribution solutions. The distribution networks rather than being focused on one single supply chain, rather cater to many supply chains, being enabled by the concepts of modularization (similar to the production system). For a Smartphone firm, the unique order placed by the customer may require unique sourcing and a unique shipment solution. A modularization approach needs to be applied to the trays, containers, vehicles, warehouses, and distribution centers. E.g., in any particular week, customers may place orders for Smartphones of varied sizes. While some orders may be of 5’’ screens, the others may be of 6’’ screens. Since, the firm following the mass customization approach, would not wish to keep pre-assembled finished products at their distribution points, the shipments will have to be timely and as per the demand. This will require the shipment containers to be flexible enough so that they can carry both screen-size phones at the same time without compromising on the capacity utilization front. Similar buffers need to be maintained in terms of time, labor costs, and inventory as well.

7. Cost Benefit Analysis

Studying the costs also becomes important for the firm to decide whether it should pursue mass customization strategies or stick to traditional production methods. This decision is generally based on the cost-benefit analysis. Economies of the integration approach enable us to study both the costs and benefits of involving a customer in the value chain (Chen & Wang, 2007).

Mass customization implicitly bears a lot of additional activity costs as compared to the traditional approach, some of which are listed below:

i. Investment in the configuration catalogues – C(C)
ii. Investment in customer service centers – C(S)
iii. Investment in highly qualified staff – C(Q)
iv. Higher distribution costs because of smaller lot sizes delivery – C(D)
v. Cost increases due to loss in economies of scale (in comparison to mass production where fully-fledged handsets are produced in large quantities) – C(E)
vi. Costs due to increased complexity in production planning and control – C(P)
vii. Higher inventory costs of components and parts (raw material and WIP inventory) – C(I)
viii. Investment in management information systems for order fulfilment management – C(M)
ix. Investment in flexible production units – C(F)

However, the mass customization approach also brings with it inherent cost savings. These savings come from economies of integration (Piller, et. al., 2004). The extent of these economies is influenced by the setting of the decoupling point and the degree of customer interaction. For a firm in the Smartphone manufacturing industry, different cost savings that can be achieved are listed down.

i. Saving the cost of rework in planning, designing and manufacturing that may have been otherwise incurred if the configuration of the phone planned by the company was not able to attract sufficient market demand – S(R)
ii. Reduction/elimination of the finished goods inventory as well as the safety stock - S(I)
iii. Reduction of the over-capacity required to the changing demand trends, hence avoiding the bullwhip effect – S(C)
iv. Avoidance of lost sales due to out-of-stock items – S(L)
v. Prevention of discounts at the end of the season – S(D)
vi. Reduction in market research costs about which configurations are desired by different market segments – S(M)

vii. Gain in information quality because the information is gathered by direct interaction rather than through surveys or third-party research agencies – S(Q)

viii. Use of the implicit information obtained for the new product development in future – S(N)

ix. Saving of the costs incurred in new customer acquisition, because the loyal customers tend to make repeated purchases – S(A)

Additional costs of mass customization = C(C) + C(S) + C(Q) + C(D) + C(E) + C(P) + C(I) + C(M) + C(F)

Savings due to economies of integration = S(R) + S(I) + S(C) + S(L) + S(D) + S(M) + S(Q) + S(N) + S(A)

If (savings due to economies of integration) > (additional costs of mass customization), it is viable for the firm in the Smartphone industry to pursue mass customization.

Note: here, we have not considered the increase in customers' willingness to pay due to customized solutions as a contributor to the benefits of mass customization through the additional premium charged. The premium should ideally be seen as an unconditional incentive for the firm to pursue the approach because it is difficult to quantify beforehand.

8. Conclusion

Mass customization has proved to be a path-breaking approach in many industries like fashion, footwear and computer. The Smartphone industry is also one such industry which has the potential to reap the benefits of mass customization, provided the entire organizational process and culture are aligned with the goal. Therefore, in this paper, we have tried to analyze how, mass customization can be smartly applied to a Smartphone manufacturing firm, ensuring that the firm can create value both for itself and for its customers. We have also studied the enablers and success factors for these firms while adopting the mass customization approach. Feasibility from a costing point of view has also been discussed. It would be interesting to see whether a mass customization approach can be followed successfully by a Smartphone manufacturing firm in the future.

However, apart from the benefits an industry can reap from Mass Customization, there are some limitations associated with the same. The Mass Customization concept relies on the inputs received from the end user's based on which the usability features are identified which acts as an input to form clusters showing similar but not the same customers. However, it gets tedious to forecast the customer's demand and sales in advance due to the wide range of available options.

And to cater to such dynamic discrete demands an additional cost gets associated with the machinery that should be capable of producing items of different colours, shapes, designs etc. Also since Mass Customization adopts Make-To-Order (MTO) manufacturing process, building stock in advance/ ahead of time is not possible. Implementation and simulation of proposed research work are left for future work. This work can be extended in the calculation of the black box value.

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