Choice Navigation Assessment for Mass Customization

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Abstract

In mass customization, the capability Choice Navigation which is defined as the ability to support customers in identifying their own solutions while minimizing the burden of choice, is essential to market high variety product portfolios effectively. We argue that there is a need for methods which can assess a company's choice navigation and their capability to develop it. Through literature study and analysis of choice navigation characteristics a number of metrics are described which can be used for assessment. The metrics are evaluated and analyzed to be applied as KPI's to help MC companies prioritize efforts in business improvement.

1 Introduction

In any company it is essential to offer products which match the needs and desires of customers in order to achieve sales and profit. This is the case for mass producers as well as mass customizers; however in mass customization this issue is somewhat more complex than mass production due to a much higher variety and a more complex product structure. As pointed out by Salvador et al., mass customizers need three fundamental capabilities to be successful (figure 1): 1) Solution Space Development – Identifying the attributes along which customer needs diverge, 2) Robust Process Design – Reusing or recombining existing organizational and value chain resources to fulfill a stream of differentiated customer needs and 3) Choice Navigation – Supporting customers in identifying their own solutions while minimizing complexity and the burden of choice [Lyons et al., 2012; Salvador et al., 2009].

In order for companies to be able to establish themselves as mass customizers or for existing mass customizers to improve performance, it is proposed that a set of methods for assessing the three capabilities is developed. In this paper, the focus is solely on the capabilities for Choice Navigation. The research question for this paper is:

What metrics can be used to assess capabilities for choice navigation and how can these be determined?

The research question is addressed by first defining choice navigation, and in overall terms, which areas should be assessed. Then a literature review is conducted to identify existing metrics. These metrics are evaluated in order to evaluate whetherthey are can be applied to assess the choice navigation performance, and a final set of metrics is developed including newly defined metrics.

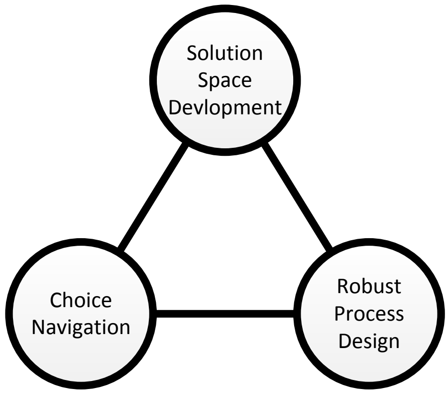

Figure 1 The three fundamental capabilities in mass customization [Salvador et al., 2009]

2 Choice navigation

The capability choice navigation is defined by Salvador et al. [Salvador et al., 2009] as "Support customers in identifying their own solutions while minimizing complexity and the burden of choice". Hence this capability is related primarily to the capabilities of the configuration system, and its ability to configure a variety of products.

Salvador et al. proposes three different approaches to develop the capabilities within choice navigation: Assortment Matching, Fast-cycle, trial-and-error learning and Embedded configuration. However these support the development of choice navigation rather than the assessment of choice navigation capabilities.

Two different perspectives are relevant when assessing a company's choice navigation capabilities. The first perspective addresses the capabilities for supporting the customer in choosing a product which matches the customer's needsfulling. The second perspective is concerned with how well the choice navigation supports the business process involved in product configuration. This paper will focus on the assessment of choice navigation purely from the customer's perspective, thus focusing on the capabilities supporting the customer in the configuration process.

The ideal product configurator should after a customer has finished a configuration leave the customer with the experience that the process has not been unnecessarily difficult to perform and the customer has been able to match his or her needs exactly to a specific configuration of a product [Salvador et al., 2009].

Supporting the customer in the configuration process, thereby making the product configuration task easy and fast, is a matter of aiding the customer in matching characteristics of needs, empowering customers in building models of needs or embedding the configuration in the product itself [Salvador et al., 2009]. Measuring how well choice navigation in a specific company ensures a 100% fit between customer needs and the goods configured by the customers is a somewhat difficult task.

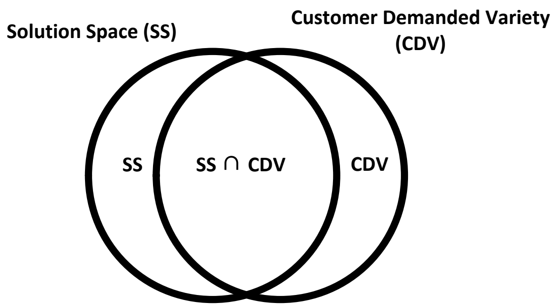

Figure 2 The intersection of offered variety and customer demanded variety yields the potential sellable products.

The problem of assessing the fit between customer needs and a configured product can be described using set theory. Since the objective of choice navigation is to match the customer demand with the offered solution space, a set is defined for each of these as illustrated in figure 2. The optimality of a solution space can then be described by defining two sets of products: 1) the different products offered by an MC company, defined as the set SS (Solution Space) and 2) the variety of products which are demanded by the customers, defined as the set CDV (Customer demanded variety). As illustrated in figure 1, the intersection of the two sets will represent the products offered by the MC company which correspond to products demanded by customers. The intersection of the two sets thus represents the products that customers may buy, given they are able to find and configure the products and willing to pay the required sales price.

Intuitively, maximizing the set SS∩CDV would seem like a good idea since this would maximize the potential number of product variants that can be sold to customers. It would also seem intuitive that the set SS \ CDV i.e. products which are part of the offered variety but are not demanded by customers should be minimized or even eliminated.

When describing these sets, it should be defined which elements are in the set or in other words. What is an element? One possibility would be that each element in the sets corresponds to a unique product variant. Following this, each possible combination of configuration choices would correspond to a variant and thus an element in the set. However, for most MC product families, the number of elements becomes astronomical due to numerous configuration variables each with a number of outcomes. For example, when configuring a Mini Cooper online the configuration choices presented to the customer will result in a number of possible variants well above a 20 digit figure. This is obviously significantly more than the potential market of the Mini Cooper. Assuming that the sale of Mini Coopers is a good representation of the demanded variety, and the Mini Cooper has sold a few million cars and assuming that each sold Mini Cooper is unique, the customer demanded variety will only be a tiny fraction of the offered variety and as a consequence. Furthermore we would expect that assessing whether single variants would counter a demand from a customer is simply not possible if the number of variants is high. Thus it would seem that variants defined as all possible combinations of configuration variables is not an appropriate way to define the solution space set as well as assessing the intersection of SS and CDV.

A more simple and comprehensible way of representing the sets may be defining the elements of the sets as the "dimensions of customization". If a product has a number of customizable attributes and each attribute has a finite number of values that can be chosen, each value will correspond to a product property which can potentially be demanded by a customer.

We thus propose that the solution space is described by the number of customizable attribute's values. For example if a product can be configured in two different sizes and ten different colors, the SS set will contain 12 elements; two size elements and ten color elements. Defining the solution space this way is trivial, since an MC company's offerings will usually be explicit in a configurator, product family model or other documentation. Defining the set CDV on the other hand is far more difficult since it will be impossible or at least extremely time consuming to clarify all potential customers' demand for variety. Also this would depend on the delimitation of the product family's intended customer base. As a result, measuring the size of CDV will expectedly be practically impossible. The intersection of SS and CDV however only describes which products match the demand of customers, and not whether the customers actually buy the products. Whether the customers buy the products is a matter of several other factors; however the first obstacle is whether the customers are able to match the needs with an actual product configuration, which is the essence of choice navigation. For this reason, we introduce another set, Customer Configuration (CC), which contains the variety that is actually being configured by customers.

The Set CC intersects with both SS and CDV as shown in figure 2, and intuitively the intersection of all three sets SS∩CDV∩CC indicates the optimal situation, where the solution space satisfies a customer demand and the customer is able to configure the product. Conversely, all variety not contained in SS∩CDV∩CC could indicate a problem.

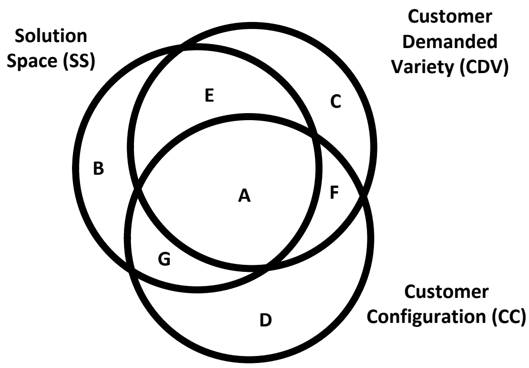

Figure 3 Intersection of Solution Space, Customer Demanded Variety and Customer Configuration

Analyzing figure 3, intersections B and C are consequences of a mismatch between the actual demand and solution space, where B implies variety which is part of the solution space but has no demand thus potentially implying unnecessary complexity costs. C implies a demand for variety that is not met by the current solution space and which may indicate an intersection where the development of the solution space could increase sales. The D intersection is seemingly less interesting in terms of choice navigation, since they relate primarily to the capabilities within solution space development.

In intersection D the customer configures a product that does not meet the demand nor is it contained in the solution space. This is not a typical situation but is nevertheless undesirable, and would likely be indicated by the customer abandoning the configuration. In intersection E, there is a match between the variety offered by the company and the customer demand; however the customer does not configure the product. This is likely a result of a user interface unable to guide the customer satisfactory through the configuration process. Intersection F indicates configuration which match a customer demand, but is outside the actual solution space, i.e. a product that can be configured but not produced, which is also highly undesirable. Finally, in intersection G the customer configures a product that is within the solution space but does not meet the demand thus resulting in a customer disappointment.

The description of the sets CC, CDV and SS above will be used in the following as criteria for evaluating and developing different metrics used for assessing choice navigation capabilities, since metrics indicating variety outside SS∩CDV∩CC will indicate sub optimality within choice navigation.

When assessing a companys capabilities within choice navigation it must be considered within which kind of business environment the configuration will be done. There is typically a great difference in choice navigation setups depending on whether the sales process is done in a business to business (B2B) or in a business to consumer (B2C) sales process. Both setups can be assessed using the same choice navigation metrics, however there are typically differences in the sales setups, where in B2B it is often the sales organization performing the actual configuration process, whereas in B2C this is typically performed by the end customers. Due to this difference, assessessment metrics for choice navigation should be investigated for bias or benchmarking issues when using the results across the different business environments B2B and B2C. We will in this paper not these differences further.

Choice Navigation metrics representing time and effort to reach a configuration, should ideally be developed so that all assessment results could be benchmarked against each other. However regocnising differences between different products and business setups, the metrics should at least allow for benchmarking within a product type and business environment.

One example where differences in product types could make benchmarking between different products non representative is where customers have a great interest in the product and actually wish to spend long time on the configuration process making it more than an experience than a transaction. In this case, a metric indicating high performance for shorter configuration processes might not be representative for the goal the configurator is designed to achieve. Hence, each metric should be scrutinized in relation to assessing a specific product, as special considerations might be relevant for special products.

3 Literature review

Blecker et al. identified and developed a number of metrics for varity steering [Blecker et al., 2003]. Some these metrics are relevant for assessment of choice navigation, and these are identified in the following along with other relevant metrics from literature.

Average configuration length of time metric (CT)

$$CT = \frac{\sum_{i=1}^{N} CT_i}{N} \quad (1)$$

CT: $average\ configuration\ lenght\ of\ time$
CT_i: $time\ needed\ for\ customer\ to\ fulfil\ one\ configuration$
N: $number\ of\ configurations$

source: [Blecker et al., 2003]

This metric measures how long time a customer or sales person uses for performning the acutal configuration process

Configuration abortion rate metric (CA)

$$CA = \frac{N_a}{N_p} \quad (2)$$

CA: $configuration\ abortion\ rate\ metric$
N_a: $number\ of\ aborted\ configuration\ processes$
N_p: $number\ of\ logins\ (started\ configurations)$

source: [Blecker et al., 2003]

The CA metric describes how frequently customers or sales people choose to abort a configuraiton which has been initiated due to whatever reason.

Customers Return Rate metric (RTR)

$$RTR = \frac{number\ og\ returned\ products}{number\ of\ delivered\ products} \quad (3)$$

source: [Piller, 2002]

The RTR metric describes how often customers returns a product to the company after receiving it due to e.g. disappointment in the product.

Customers Churn Rate metric (CR)

$$CR(\Delta T) = \frac{NOLC(\Delta T)}{NOC(\Delta T) + NONC(\Delta T) - NOLC(\Delta T)} \quad (4)$$

$NOLC$: $number\ of\ lost\ customers\ at\ \Delta T$
NOC: $number\ of\ customers\ at\ T$
$NONC$: $number\ of\ new\ customers\ at\ \Delta T$

source: [Sterne, 2003]

The CR metric describes the relationship between new customers and lost customers.

Customers Repurchase Rate metric (RR)

$$RR = \frac{repurchase\ through\ existing\ customers\ (\Delta T)}{number\ of\ new\ customers\ (\Delta T)} \quad (5)$$

source: [Piller, 2002]

The RR metric describes how often products are repurchased, or how often customers return to byt another different product.

Customers Complaints Rate metric (COR)

$$COR = \frac{number\ of\ complaints\ (\Delta T)}{number\ of\ deliveries\ (\Delta T)} \quad (6)$$

source: [Blecker et al., 2003]

Similar to the CR metric, the COR metric describes how often customers complain over a product they have purchased after receiving it.

Walcher and Piller conducted a survey of 500 different mass customization companies, and for this purpose they developed a number of metrics for comparing the different mass customizers [Walcher & Piller, 2012]. The analysis focused primarily on the configurators, i.e. choice navigation but also on the products. Four objective metrics were included:

- Visual features – To what extent the product is visualized as it is configured, e.g. 2D picture, multuple views, Zoom etc.
- Navigation help – Whether help like progress bars, activity lists, option to save etc. is provided
- Company help – Whether help like recommendations, deeper explanations, design examples etc. is present
- Customer help – Whether users of the configurator is able to get help or inspiration from other users directly or indirectly.

The metrics were evaluated on a scale from 0-4 representing how many of the elements were found in each configurator.

Furthermore, evaluators which were independent mass customization experts were asked to evaluate each configurator using the following subjective metrics:

- Visual realism
- Usability
- Creativity
- Enjoyment
- Uniqueness
- Choice options

Each metric consisted of a number of sub-metrics which the evaluators were asked to assign a rating between 1 and 5. Each configurator was evaluated by 3 different experts and an average was calculated for each metric for each configurator.

4 Choice navigation metrics

In order to evaluate which metrics are usable for evaluating choice navigation capabilities, the different set intersections illustrated in figure 2 are addressed individually. For each intersection, it is evaluated which metrics can support the assessment.

Another requirement for the metrics is that they should be measurable based on readily available data in a company's IT systems, i.e. ERP, CRM, PLM and configuration systems, since this would allow mass customizers to utilize these metrics for continous improvement.

Please note that intersections B and C are disregarded in this context since they relate more to capabilities within solution space development than choice navigation.

4.1 Intersection E

In this case, the customer will start to configure a product, but never reach a final configuration which is purchased, although the solution space supports the requirements. This is difficult to distinguish from the case where requirements cannot be met within the existing solution space (intersection C), however high CA metric can be used as an indication since customers that cannot configure a product to meet their requirements will likely abandon the configuration.

Furthermore, if configurations utilise only a small portion of the solution space and if many configuration variables, rarely deviate from the default values, that may indicate that customers are not aware of all possible variety and have therefore not been able to configure a suitable product although it is in fact offered.

4.2 Intersection F

In this case, customers configure products which are within the customer demanded variety but outside the solution space, i.e. a product is configured which cannot be delivered. This would likely result in the order being cancelled by the company, since it cannot be manufactured. Alternatively, the company will change the configuration to fit within the solution space by e.g. upgrading the product. As an indicator for these configurations we introduce two new metrics:

Seller Order Cancellation rate (SOCR)

$$SOCR = \frac{number\ of\ orders\ cancelled\ by\ seller}{number\ of\ placed\ orders} \quad (7)$$

Seller Order change rate after purchase (SOCRAP)

$$SOCRAP = \frac{number\ of\ orders\ changed\ by\ seller}{number\ of\ placed\ orders} \quad (8)$$

High values of SOCR and SOCRAP would then indicate configurations within intersection F.

Configurations within intersection F as well as D would be a result of a faulty implementation of a configurator, since a configurator should ideally reflect the company's solution space or a subset of the solution space. Reaching configurations within intersection F and D is very undesirable, since it will lead to loss of credibility as well as a need for costly manual business processes to resolve the issue.

4.3 Intersection G

In this case, the customer configures a product which is within solution space but does not correspond to the customer's requirements. In this case several things could happen. If the customer realises that the product is not satisfactory prior to delivery, the customer may cancel the order or change the configuration. To indicate this, two new metrics are introduced:

Customer Order Cancellation rate (COCR)

$$COCR = \frac{number\ of\ orders\ cancelled\ by\ customer}{number\ of\ placed\ orders} (9)$$

Customer Order change rate after purchase (COCRAP)

$$COCRAP = \frac{no.of\ orders\ changed\ by\ customer}{number\ of\ placed\ orders} (10)$$

In other cases, customers will not realise that the configured product does not meet requirements, until it is received. In this case the customer may return the product (indicated by RTR) or complain (indicated by COR). Also repurchase rates (RR) and churn rates (CR) would be affected.

Hence configurations within intersection G would be indicated by high values of COCR, COCRAP, RTR and COR and CR and low values of RR.

4.4 Intersection D

In this intersection, the customer configures a product with properties that the customer does not have a demand for and is not part of the solution space. In this case either the customer or the company can react to this and either cancel or change the order. Hence configurations in intersection D will be indicated by High values of SOCR, SOCRAP, COCR and COCRAP. It may however be difficult to determine whether high values of SOCR and SOCRAP are due to configurations in intersection D or F. On the other hand, the customer does not receive the product no matter which are the configuration is in, so whether the customer had a demand for the product may be less important.

4.5 Intersection A

Basically, sales within intersection A are the optimal solution, since products are sold within the solution space which also match the customers' requirements. Hence if there is little indication of configurations outside intersection A, then that should indicate that configurations are within intersection A. Since configurations within intersection A should lead to a sale, then an increase in CSR would also indicate an increase in configurations within intersection A.

Configuration sales rate metric(CSR)

$$CSR = \frac{number\ of\ sold\ configurations}{number\ of\ started\ configurations} \quad (11)$$

4.6 Further metrics

Apart from the metrics which relate directly to the intersections A-G, we identified a number of metrics which may be used to explain why configurations occur in intersections outside intersection A. Hence the metrics can be used to explain the possible reasons for a problem with a configuration system rather than whether there is in fact a problem.

Configuration click index metrics(CI)

$$\mathrm{CI}_c = \frac{\sum_1^n C}{V} \quad (12)$$

CI_c: $clicks\ index\ of\ configuration$
n: $numberofconfiguration\ in\ index\ (min\ 100)$
C: $number\ of\ clicks\ used\ for\ configuration\ i$
V: $numbers\ of\ outcome\ of\ variables$

CI metric is a measure of the number of selections, choices or clicks the customer makes in the configurator; or in other words the effort needed by the customer for performing the configuration. It could be the number of selections or actions which the customer has made for a number of given configurations indexed with the total number of variables available in the configurator. The metric cannot be used as benchmark in general or as comparison to other companies/configurators but it can be used internally as an indicator for how a change due to implementation of new variables in the configurator or change of configurator has impacted the choice navigation performance. Increase of CI may indicate more complex choice navigation or an increase in burden of choice navigation. In a broad view it can be argued that a a value of CI at or near one may indicate a perfect choice navigation.

Time used in configuration index metric(TI)

$$\mathrm{TI}_c = \frac{\sum_1^n T}{V} \quad (13)$$

TI_c: *configuration time index*
n: *numberofconfiguration in index* (min 100)
T: *time in seconds used for configuration*
V: *numbers of outcome of variables*

As for CI the TI metrics gives an index of the time used for a number of given configurations. As for CI the TI may be used internally as an indication of change in burden of choice caused by change of variables and/or change of configurator.

Some of the metrics defined in MC500[Walcher & Piller, 2011] can also be utilized as metrics in this context. However only the objective metrics are included here, and thereby not the metrics that are based on a subjective evaluation. The included metrics are:

- Visual features
- Navigation help
- Company help
- Customer help

All of these metrics are indicators of how customers are guided or helped through the configuration process. Given a company finds that many configurations are observed in intersections E or G, then looking into these metrics may explain the reasons for this.

5 Conclusion & Dicsussion

In order to support the development of choice navigation in mass customization and thereby also product configuration, metrics are needed in order to assess the choice navigation performance. To establish these metrics, relevant literature was reviewed and several applicable metrics were identified. Further metrics were defined in areas where no sufficient metrics could be identified in literature. The following list compiles the metrics identified in literature and newly defined metrics within choice navigation:

Metrics identified in the literature

- Configuration abortion rate metric (CA)
- Customers Return Rate metric (RTR)
- Customers Churn Rate metric (CR)
- Customers Repurchase Rate metric (RR)
- Customers Complaints Rate metric (COR)

Newly defined metrics

- Seller Order Cancellation rate (SOCR)
- Seller Order change rate after purchase (SOCRAP)
- Customer Order Cancellation rate (COCR)
- Customer Order change rate after purchase (COCRAP)
- Configuration sales rate metric(CSR)

It is the intention that these metrics can be used in MC companies for different purposes. One purpose is benchmarking against “best practice” mass customizers, in order to identify areas with the greatest potential for improvement. Another purpose is to use these metrics as key performance indicators which are continually calculated to monitor performance to continuously improve. In relation to research in mass customization it is the intention to apply these metrics in different types of mass customization companies to analyze what distinguishes successful mass customizers.

It is evident that the application of these metrics poses certain requirements related to data availability and quality. However, most MC companies already have systems in place which are very likely to contain the data required for calculating the metrics presented in this paper.

As mentioned in the introduction, choice navigation is one of three fundamental capabilities for successful mass customizers; the other two being robust process design and solution space development. There are strong relations between these three capabilities, and phenomena experienced in a company cannot necessarily be attributed to only one capability, and as such, the metrics defined in this paper can also be influenced by other factors than the solution space development capability.

One example is the metric configuration abortion rate which we argue indicates how well choice navigation is implemented. However, the configuration abortion rate will be strongly influenced by the solution space, i.e. how well the offered variety matches the demanded variety. The value of this metric can thus both be influenced by a company’s performance within choice navigation as well as solution space development. In future research, metrics for the other two capabilities, Robust Process Design and Solution Space Development should be established and the links between all three capabilities can be analyzed. Furthermore, the relations between metrics performance and specific methods should be addressed so that an assessment could point out not only what a company should do to improve but also how.

When performing an assessment and interpreting the values of the metrics, the interpretation should take into account the product type. Also when benchmarking, different products cannot necessarily be compared directly. The reason for this is that several metrics are based on the customers actions, and these actions will depend on the product type. For exampe if a customer buys a customized car compared to a customized bag of muesli, then the customer would probably be more likely to complain or return the car if it has a wrong color compared to the muesli, if a wrong ingredient has been added. In that case, the difference would be due to the dfference in cost of the products. Furthermore a metric like the repurchase rate makes more sense for some product types than others. For example, customers are likely to repurchase muesli more often than cars. So this metric would depend on to what extent a product can be characterised as a consumable or a durable, and in case it is a durable, how long the life cycle is.

With this paper we have ended a preliminary research of assessment and measurement of the mass customization process. We have with this paper finalized a general approach describing how to assess and measure mass customizatioin and developed a framework of potential metrics useful for assessment and measurement of mass customization, whether this is for the purpose of internal performance indicators or it is used for benchmarking in general. Next phase in this research will be test and evaluation of the metrics.

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