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A FRAMEWORK STUDY ON ASSESSMENT OF MASS CUSTOMIZATION CAPABILITIES

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Abstract: *Much research has been done to assist industries to move from mass production to mass customization. Salvador F., et al. made it clear in the article "Cracking the code of Mass Customization", that becoming a Mass Customizer is not a single step quick fix, but requires 3 fundamental capabilities. In that article it is proposed that these three capabilities are evaluated in a continuum model as an illustration of a company's status of mass customization.*
This paper will introduce the neccesarity for a framework for measuring a company's performance as a mass customizer.
Key Words: ***Framework, Assessment, Mass Customization, Capabilities, Solution Space Development, Choice Navigation, Robust Process Design***

1. INTRODUCTION

To address the increasing customer demand for personally customized products, Mass Customization, Personalization and Co-creation (MCPC) has been widely adopted as a competitive business strategy during the last two decades [1],[2],[3],[4]. Many companies have within the same period acknowledged that the implementation MCPC is much more complicated than immediately anticipated and in some cases even jeopardized the existence of the company instead increasing competitiveness. Of course others have shown the road to success like DELL, BMW, and ADIDAS [4]. Due to the large difference in success for companies implementing MCPC, analyses and method development has been addressed extensively in literature [5],[6].

In the article "Cracking the Code of Mass Customization" [4] the authors argue against the common executive perception of MCPC as a "fascinating but impractical idea", by introducing the concept of 3 fundamental capabilities as success factors, based on the results from substantial research of 238 companies in eight countries. The three capabilities required for successful implementation of MCPC are 1) Solution Space Development, 2) Robust Process Design, and 3) Choice Navigation [4]. The three capabilities are each supported by three approaches to achieve that specific capability (fig. 1.).

Solutions Space Development
Understanding customers' idiosyncratic needs
- Innovation Tool Kits
- Virtuel Concept Testing
- Customers Experience Intelligence

Robust Process Design
Reuse and/or recombine organizational resources to fulfill different customers' needs efficiently
- Flexible Automation
- Process Modularity
- Adaptive Human Capital

Choice Navigation
Supporting the customer in identifying appropriate solutions without getting confused
- Assortment Matching
- Fast Cycle trial-and –error learning
- Embedded Configuration

Fig. 1 *The three fundamental capabilities and approaches to develop* [4].

Each capability is described as a continuum i.e. a company can be extremely capable, not capable at all or anything in between in relation to each capability. A company being highly capable within each of the three capabilities could thus be considered the ideal mass customizer, whereas a company being less capable would indicate a mass production company not very capable of mass customizing. An example of mapping the three capabilities,is shown in figure 2. Identifying for which capability a company has the lowest performance (being least capable), would thus help the company identifying where to focus its effort to boost its chances of success in a mass customization market.

Since the publication of Cracking the Code of Mass Customization [4] several scientific publications have addressed how to improve each capability [7],[8],[9]. Prior to this a number of publications have also addressed these issues, although using different terms for similar concepts. [5],[6].

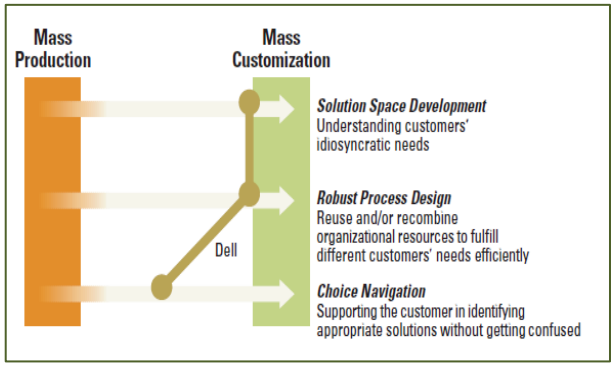

Fig. 2 *The Mass Customization Continuum* [4].

The approaches which are proposed in relation to "Cracking the code of mass Customization" are validated through intensive research [4],[10], but except the illustration of the MC continuum (fig. 2) [4] no guidelines are presented how to assess the capabilities in practice in a company. Furthermore, it is argued by [4] that there is not one magic bullet or a single quick fix which enables a high performance within each capability thus ensuring successful MC. Hence, it appears that it may be difficult for companies striving for Mass Customization to identify how to improve the capabilities, as no generic guidelines can be followed and an assessment is not immediately possible.

Based on case studies and surveys [10] it has been shown that gaining capabilities and thereby becoming a better mass customizer is done by small incremental improvements e.g. by using the approaches presented in literature. However, for incremental changes to be worthwhile, they must be focused at the right area, i.e. within the specific capability that has the greatest potential for improvement. Given that a company has limited resources to implement improvement of the three capabilities, the resources should be focused on the capability where an investment would yield the greatest effect on overall competitiveness. We hypothesize that the greatest effect would usually be within the capability where the company has the lowest performance. Referring to the Dell example in figure 2, an investment in developing capabilities would make most sense within choice navigation, since Dell has excellent performance within solution space development and robust process design. This is not saying that improving those capabilities would not at all be worthwhile, but it is likely that the relative improvement of overall competitiveness would be greater if focusing on choice navigation.

However, to be able to focus the improvement effort according to capability performance, companies must be able to assess how they perform within each capability and relate them to each other to establish a relative performance to prioritize improvement efforts. Since we have not been able to identify methods for assessing the capabilities, we assume that practitioners do not apply structured methods for capability assessment. It may on the other hand be possible that managers intuitively can tell which capability would yield the greatest potential for improvement, but that would rely on management experience and business insight rather than methodical analyses. This would imply that some companies would undoubtedly be able to confidently assess the performance within each capability and prioritize optimally, some companies would get lucky while others would fail due to lack of experience and insight. Following this we hypothesize that companies today are generally not able to assess their mass customization capabilities and a methodical tool for this would aid mass customizers in achieving competitiveness through mass customization.

1.1 Research question

The overall purpose of this paper is to analyze the need for mass customization capability assessment methods and contribute to enabling the measurement of mass customization capabilities to enable mass customizers to increase competitiveness. However, to be able to enable the measurement of the capabilities, it must be determined which variables can be used to measure these capabilities and how they are related. The main research questions of this paper are thus:

Q1: Are companies able to assess mass customization capabilities and prioritize improvement efforts accordingly?

Q2: Which variables can be used to explain the three mass customization capabilities and how are they interrelated?

1.2 Methods

Research question 1 will be addressed through three case studies. The case studies focus on three very different companies which are all moving towards mass customization but have chosen significantly different paths towards this goal. Each case is analyzed to qualitatively assess their capabilities within the three different areas and whether they are able to pin out which capability to focus on to achieve the greatest improvements. By doing this we can arrive at a conclusion whether assessing MC capabilities is a trivial task in industry.

Research question 2 will be answered by reviewing literature to identify parameters useful for measuring MC capabilities as well as the findings from the case studies will be used to identify how companies evaluate their MC capabilities. Once the parameters are identified, the relations between them will be identified and a summarizing framework will be presented, including the measurement parameters, their interrelation and their relations to the three capabilities.

2. CASE STUDIES

Each of following cases has been involved in mass customization in different levels of implementation and with different approaches to achieve the fundamental capabilities. None of the cases have been working towards mass customization following schemes like the systematic analysis of capabilities and prioritized efforts accordingly. The knowledge collected at these companies for the case studies has been collected in relation to individual projects with different objectives than what is presented in this paper. Because of that the cases are neither uniform in description nor in data.

2.2 Case 1

This case is about a company, developing, producing and selling truck lifting equipment, primarily in Europe. The company has through the last decade developed the company in different areas to increase its competitiveness, which could be expressed in MC terms. Solutions Space development is done primarily in an engineer driven traditional new product development department. As an approach to customer driven development the company has offered product development seminars for selected customers. Variants and new product platforms are enrolled into new products in predefined product management based on modular product structures, which are related to both production process capability and choice navigation capability. The production has undergone a change from line production into production cells based on lean and agile production philosophies. The production process and handling of variants are defined by the product structure and production documents are ideally automated produced based on selection made in the product configurator. The choice navigation is done from classic leaflets and brochure, supplied with matrix selectors for variants. To document the customer requirements an engineer controlled product configurator is used. The solution space is converted into spreadsheets which are used in the product configurator.

The company has through the last 10 years initial increased its market share and opened new markets, but through the financial crisis suffered loss on the bottom line due to loss in market share and smaller gross margin which seems to be derived from customization which is closer to *engineer-to-order* than *mass customization*.

2.3 Case 2

This case is about a company manufacturing work wear to the service sector, primarily to the northern European market. The company has during the last decade added market and gained new customer by moving from highly specialized customer order design to manufacturing based on modularized product design. The company has developed its new solution space in an internal design studio based on market research studies. Like most other actors within the apparel industries this company has sub suppliers in the Far East, with product structures, operations routes, and logistics which calls for mass production rather than going for mass customization. The process design has taken the manufacturing process from the Far East back to Europe, partly because of faster delivery and easier communication from entry of order to delivery. Choice navigation has been simplified to a leaflet working like the old fashioned paper doll toy, which in the end by help of a designer creates a unique documentation, within a predefined solution space.

The company has over the last 10 years increased its markets share but suffered also a decrease when the financial crisis hit their customers, they have since introduction of the above mentioned product line increased its market shares more than anticipated alone related to market development.

2.4 Case 3

A major pump manufacturing company, developing, manufacturing and selling in the global market is in the final steps of introducing the third generation of green domestic water pumps. As it is indicated there has been two generations of pumps prior to this, which has been marketed in a relative simple solution space (up 20 variants). The company's strategy behind new third generation derives from the green competition in the market and legislation for low energy consumption. Within a relative short period of time new product platforms have been developed and more efficiently manufacturing process's developed accordingly. Each generation has been developed with more and more customer involvement in the design process, even so the on market has decreased, because new need's has to be fulfilled, need's beyond the capable solution space, capable process's, and capable choice navigation. Each generation has been manufactured in an environment in a strong and robust process design, well defined solution space, and choice navigation which matches the other two capabilities. The first two generations defined with a fervent desire first of all to have optimum capability in the robust process design. The newest generation has once again focus on a robust process design which supports a more capable solution space which over time can expand to customer's needs. The robust process designs are expressed in a full automated manufacturing line which is scalable in volume of production and accepts a large variety, beyond the initially defined solution space. The product itself furthermore has embedded configuration.

These products are the core products and one of major income for the company, which makes improvements essential for the survival of the company.

2.5 Case Discussion

Common for what was observed in the three case companies is that they are all moving toward mass customization, however using different approaches. None of the companies had an explicit strategy for balancing the effort between the three MC capabilities and certainly not a structured approach for assessing their capabilities.

Based on these cases and other cases from literature it is argued that a common or generic framework to assess the customization level is needed. It is argued that such framework should cover assessment of three capabilities with comparable scores, levels, numbers, and/or datasets. Ideally this should be based on common data or data easily produced in a company, making it possible to make benchmark internally as well as externally too.

Measuring a capability is not a matter of just dipping the thermometer and reading the numbers, as well as being a mass customizer is not a matter of a single decision or single action[4],[11]. Based on above case studies it is argued that measurable expressions of the three capabilities need to be established.

3. MEASURABLE CAPABILITY PARAMETERS

In the literature controllable and analyzable parameters can be identified as KPI's and standardized

variables often related to the financial reporting. Financial reporting is used as periodical status for public interests and as an instrument used by investors [12]. Standardized financial reports are characterized by explicit data (parameters, variables, and numbers) all comparable across companies and industries, which make them useful in indexing capabilities if it is possible to establish relationships or correlation between financial reports elements and capabilities, in this case the three MC capabilities. Other research has revealed in depth analysis and models of how relationships of processes in a mass customizer company could be expressed, this work has led to models of "Key Metrics Systems for variety Steering in Mass Customization" [13],[14],[15],[16],[17]. The models are based on MC sub processes and in relation to each process parameters and calculations behind these parameters are suggested. Both the standardized financial report and the *Key Metrics System model* are used as basis for further analysis of potential parameters to measure *the three fundamental capabilities*.

3.1 Standardized Financial Report Parameters

Building relationships between Standardized Finance Reporting parameters or variables and *the three fundamental capabilities* does not reveal any explicit relationship or correlation useful for, analyzing, or measuring the company's status as mass customizer (see table 1). Because of its nature as a summarized statement (standardized following international agreed procedures) in each of the financial standardized parameters it is possible to establish relationships to all three capabilities for each parameter.

Table 1. *Relationships Standardized Financial Report and the three capabilities in mass customization.*

Standard Finance reports (ref IFRS)	**MC**		
	SSD	RPD	CN
Sale of Goods			■
Cost of Sales		■	■
Gross Profit			
Selling and Distribution Cost		■	■
Administrative Expenses	■	■	■
Other Operating Expenses	■	■	■
Operating Profit			
Finance Cost	■	■	■
Finance Income			
Profit before tax			
Tax			
Profit			

Nevertheless each parameter has underlying detailed specifications with data which can be related to specific capabilities. A financial report can be analyzed into more detailed figures and KPIs by using financial ratios and other financial analytic tools. Examples of these are DuPont model (fig. 3), ABC-model or similar or by decomposing International Standardized Financial Report using International Accounting Standards [12].

An example is Sales of goods are related to Choice Navigation, ideally sales are selection of specific variants which fulfill the customers' needs, as assortment matching or fast-cycle, trial-and-error-learning processes which are IT supported often as product configurators, guided selectors etc.

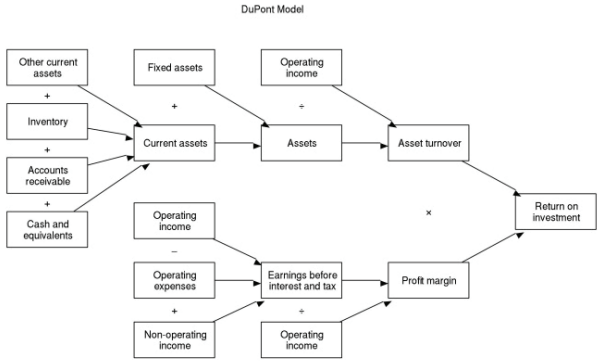

Fig. 3 *Examples of detailed parameters or variables useful as indicators to assess status of mass customization if relationship to the thre capabilities can be established.*[11]

3.2 Key Metrics System parameters

Through literature review the *Key Metrics System model* has been delimitated as the one of the best candidate to deliver useful parameters, measurable parameters, and validated parameters within the mass customization processes [17]. The *key Metrics System model* has been presented and developed as a means to variety steering in mass customization. Research for the *Key Metrics System model* (figure 4) has been based on reviews of different approaches to mass customization, which not only strengthens the validity of the parameters for use in a framework seeking measurable parameters within mass customization, but have roots to almost all relevant research in the domain, too. In table 2 the relationship matrix indicating correlation between parameter used in the *key metrics system model* and the three capabilities.

Opposed to the standardized Financial Report it seems that at high level *Key Metrics System Model parameters* explicit can be identified as good candidates as measurable parameters for *the three fundamental capabilities*. Further analysis of the *Key Metrics System model* reveals further detailed calculable parameters all on a basis common accepted KPIs.

As an example the Used Variety [17] can be explained as the perceived variety compared to the theoretically possible variety; a number between 0 and 1 and theoretically simple to calculate.
A low number indicates that product variants could be uninteresting or may not be perceived by costumers [17], which could either be related to ineffective Solution Space Development or inadequate Choice Navigation. In this example *Innovation toolkit* as an approach could be the answer to improve the capability Solution Space Development or Assortment matching software to improve Choice Navigation.

Table 2. *Relationship Key Metrics System parameters and the three fundamental Capabilities for Mass Customization. (Modified from* [16] *(fig. 17, pp. 17)*

Key Metric System elements	**MC cap**		
	SSD	RPD	CN
Product Architecture	■		
Web appearance and data format			■
Used Variety	■		■
Components Commonality	■		■
Production Process Commonality		■	
Purchasing Process Commonality	■	■	
Modules Suppliers Weight	■	■	
Setup Duration			■
Potential Customer Happiness			■
New Customers Base	■		■
Repurchase	■		■
Sales			■

customization. It has been recognized that at least 20% of MC startups leave business within 12 months [18]. It seems that even though it has been recognized that the three capabilities are fundamental[3],[11],[19], the research in models, methods, and tools describing the correlation or relationship between *the three fundamental capabilities* and accepted models, models, and tools for business models has been sporadic and much of that research have been done before a general acceptance of *the three fundamental capabilities* and the correlated approaches was presented in 2009. *The three fundamental capabilities* and the related approaches to achieve the capabilities are the backbone for the work to establish a framework to assess *the three fundamental capabilities* for mass customization. The well placed criticism in doing that is a matter of "are these three capabilities for mass customization enough fundamental to be the only ones?" – Probably not, but for this work it has been marked as sufficient. Of course other and probably fundamental capabilities to run a general business are needed in a mass

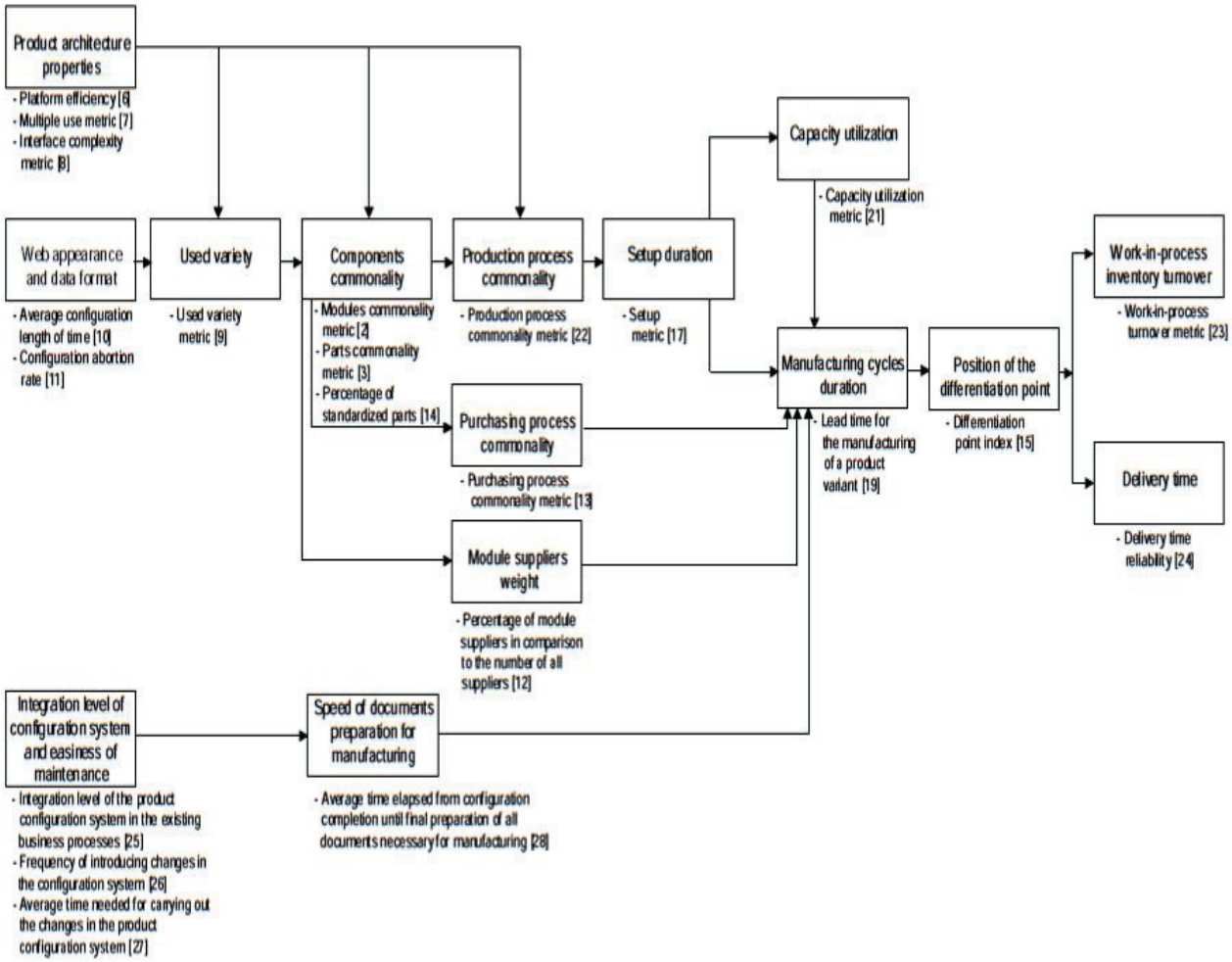

Fig. 4 *Key Metrics System model* [15]

4. DISCUSSION AND CONCLUSIONS

Establishing a framework to assess *the three fundamental capabilities* could be a way to keep the industry staying in business and aiming further for mass customization business, but solely to aim for mass customization *the three fundamental capabilities* are covering the needs.

The case studies behind this work have revealed that a framework should cover assessment of three capabilities with comparable scores, levels, numbers, and/or datasets. Ideally this should be based on common data or data easily produced in a company, making it possible to make benchmark internally as well as externally too.

It has been found that measuring capability is not a matter of just dipping the thermometer and reading the numbers. Furthermore, other works indicate that establishing capabilities is not a matter of a single discussion or single action by management, but requires continuous attention by management as other strategic processes [4],[11].

Establishing assessment data or gain knowledge about and have well the mass customization process are working, cannot be established alone by analyzing a company's financial report. A relationship matrix has been established but reveals little explicit information which could be related to individual capabilities. An example of the difficulties in using the financial report as assessment alone is: *the variable cost of production*, which is the financial result of involved manufacturing processes, including related or accumulated direct product related variable cost coming from process design like flexible automation or process modularity and sales systems setup as running cost of IT-systems for configuration or web-sale-services[12], of which all are related to both Robust Process Design and Choice Navigation[4].

A relationship matrix between *key metrics system model parameters* and *the three fundamental capabilities* indicates that specific equations, datasets, and/or number can be correlated or related to specific capabilities.

It has been indicated that it is necessary to establish a framework to assess *the three fundamental capabilities*. This indication is based on information gathered from three cases describing companies approaching the mass customization process with different strategies and management engagement; even though it is argued that they are working blindfolded and have nothing or in best cases small indication whether their efforts bring them closer to a better business based on mass customization. The work indicates that a framework to assess the mass customization process can be established analyzing standard financial reports using standardized and accepted methods and tools and by analyzing using equations and data, based on *key metrics system model parameters*.

Future work should address establishing tools to assess the individual performance within *the three fundamental capabilities*. Additional work has been done to exemplify how to establish knowledge about variables and parameters useful to assess Solution Space Development, this work is presented in the paper "Solution Space Assessment for Mass Customization"[20].

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