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THE STATE OF THE ART OF THE RESEARCH IN MASS CUSTOMIZATION IMPLEMENTATION GUIDELINES

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Abstract: *Interest for mass customization (MC) is constantly growing in industry and academia. However, a number of failures in adopting MC has been reported. It seems that the academic knowledge accumulated on MC is transferred to practice to a limited extent. MC implementation guidelines is a type of academic research that is specifically designed to transfer this knowledge to practice. However, it is still unclear what MC implementation guidelines characteristics should be. This paper reviews relevant literature in order to identify characteristics of MC implementation guidelines currently available. It also defines directions for the future research on MC implementation guidelines development.*

Key Words: ***Mass Customization, Implementation Guidelines, Implementation, Literature Review***

1. INTRODUCTION

Mass customization (MC) can be defined as an organization's ability to provide customized products and services that fulfill each customer's idiosyncratic needs without considerable tradeoffs in cost, delivery and quality [1]–[3]. Literature reviews done in the field of MC witness the relevance of the research field [4]–[7]. Researchers agree that MC provides competitive advantage [5], [8]–[10] through product differentiation [11], manufacturing flexibility and quick responsiveness [12], [13]. Still a number of MC implementation failures is reported in the literature [14]–[18].

The reasons for MC implementation failures differ. For Toyota it was pushing the use of common components among the Toyota car models and solution space defining [14] which led to rise of Toyota car prices that endangered the company [15]. Nissan had a problem with product space development offering high variety of steering wheels with many of them not being bought [14]. Failure of Levi's in 2003 was attributed to lack of color choice in customization of jeans [16]. Dell's failure was caused by non-suitability of his customization model that could not cope with a big market change [16]. GM and Ford had car dealers positioned between company and customer which did not go in favor of MC implementation direct sales concept [17]. Indian paint industry failed to materialize on implementation of product configurator and postponement practices since they neglected to analyze customer needs [18]. In sum, mentioned failures have occurred because of either overdoing part standardization, poor solution space defining, lack of product variety, non-suitable customization model, non-suitable sales model and lack of customer needs analysis.

Even though these failures show that there is a need to better define MC implementation in order to avoid them, there is no agreement in the literature on characteristics of MC implementation guidelines. On one hand MC implementation has been emphasized as an important topic by a number of scholars [19]–[21]. On the other hand, the above mentioned MC implementation failures signal that there is no clear view of how managers should implement MC. We can argue that not being clear on how to implement MC goes hand in hand with the lack of clarity on what are characteristics of MC implementation guidelines from practitioner's point of view.

Thus, our goal is to define characteristics of MC implementation guidelines through systematic review of the relevant MC literature. The research has been done with paying attention to possible practitioners' points of view.

The rest of this paper is organized in four sections. Literature review method section provides search strategy and coding criteria. Results section provides overview of the results obtained through analysis of relevant papers. In Discussion section obtained results are discussed, while in Conclusions section findings are drawn and directions for future work defined.[1]

2. LITERATURE REVIEW METHOD

In order to identify the characteristics of MC implementation guidelines we performed a literature review. The literature review is a method suitable to summarize the state of the art in the subject field and to identify future research opportunities [22]. In order to perform the literature review rigorously, a method must be clearly defined [22]–[24]. Consequently, in the remainder of this section, the search strategy, article selection process, and coding criteria applied in the research will be presented.

[1] NOTE: Data presented in this paper is still to be reassessed. This is due to a fact that selection and inductive coding criteria are not yet the final ones. For this reason specific numbers and references may change.

2.1. Search strategy/Article selection

The present literature review focuses on the implementation guidelines provided in academic literature to move towards MC. Consequently, prior to the literature search, keywords were defined by considering the terms that can be used to communicate the idea of an "MC implementation guideline" or "MC implementation methodology". These keywords allowed us to focus the search of all relevant articles.

The search for relevant publications was performed in Scopus database. The search was conducted on Article Title, Abstract and Keywords. The search terms were "mass customization"/"mass customisation" in combination with at least one of the terms "implementation", "methodology", "mov*" (moving towards etc.), "enabl*" (enabler, enabling, enable, etc.), "adopt*" (adoption, adopt, etc.), "obstacl*" (obstacle, obstacles, etc.) or "guid*" (guide, guidelines, etc.). We further excluded conference papers, conference reviews, books and book chapters. This choice follows the motivation provided by Fogliatto et al. (2012) that MC research is mature enough to allow search of significant research contribution on articles only. Furthermore, only publications in English language were taken into account. Initial search yielded 549 articles.

Further selection of 549 articles was done based on journal quality. Thus, articles published in journals with higher ranking/reputation (Q1 and/or Q2 journals by Scimago rankings) were kept in selection. These criteria led to 387 publications published in 145 journals.

A number of papers in MC literature calls for a holistic approach to MC implementation [20], [25]–[30]. In line with calls for holistic approach, from MC literature it is also evident that MC is a result of more than one MC enabler [5], [7], [26], [31]–[40]. In order to take this conclusion into account in our search we opted to focus on those papers that fulfil the following criterions (1 and (2 or 3)):

Criterion (1)	Research is presented in a way that can guide MC implementation in practice
Criterion (2)	Paper provides interdependence relationships between two or more MC enablers
Criterion (3)	Paper provides detailed implementation instructions for two or more MC enablers

Using criterion (1) through abstract reading we reached 242 papers. By applying criterion (1) papers not focused on providing guidelines for MC implementation were excluded. Notably, criterion (1) presents the main criterion in the selection process. As such, criterion (1) was reapplied in subsequent selection steps along with criteria (2) and (3).

In the next selection step, by applying criteria (2) and/or (3), through full text scanning we eliminated further 159 papers reaching 83 papers. Thus, papers focusing on a single enabler were excluded. Yet, deeper analysis was needed in order to confirm that that these 83 papers comply with the set criterions.

In the final step, analysis through full text reading was done and all three criteria applied once again. In outcome only 13 papers fulfilled criterion (1), and criteria (2) or (3). Results presented in the remaining of the paper are based on deep analysis of these 13 papers. Overview of 13 relevant papers by journal is given in Table 1.

Table 1. *Journal overview with number of papers*

Journal name	No. of articles
International Journal of Computer Integrated Manufacturing	2
AI EDAM: Artificial Intelligence for Engineering Design, Analysis and Manufacturing	1
International Journal of Production Research	1
Business Horizons	1
Concurrent Engineering: Research and Applications	1
Journal of Intelligent Manufacturing	1
IIE Transactions (Institute of Industrial Engineers)	1
Engineering Optimization	1
Journal of Systems and Software	1
Open Construction & Building Technology Journal	1
Research in Engineering Design	1
Strojniski Vestnik/Journal of Mechanical Engineering	1

2.2. Coding criteria

Unfortunately, we did not find a research framework suitable to guide analysis of the relevant articles. For this reason, classification criteria to be used in the analysis were identified inductively [41]. All of the classification criteria were firmly set, articles were reanalyzed and reassessed. Further we move toward classification scheme used for analysis of relevant papers (Table 2).

Table 2. *Classification dimensions with coding values*

MC overview - with possible classification values: 1) MC overview provided 2) MC overview not provided
Applicability context - with possible classification values: 1) Applicability context listed and justified 2) Applicability context listed 3) Applicability context not explicitly stated, but self-evident 4) Applicability context not discussed at all
Required resources - with possible classification values: 1) Required resources addressed 2) Required resources not addressed
As-is analysis tools – with possible classification values: 1) As-is analysis tools provided 2) As-is analysis tools not provided
Hindrance factors - with possible classification values: 1) Hindrance factors provided 2) Hindrance factors not provided
Instruction contents – with possible classification values: a) *Single enabler implementation instructions* – with two possible values: i) Single enabler instructions provided ii) Single enabler implementation instructions not provided b) *Multiple enabler interdependence implementation instructions* – with two possible values: i) Two or more enablers are related to each other in the guidelines ii) No enablers are related to each other in the guidelines
Instruction exemplification - with possible classification values: a) Exemplified implementation instructions b) Non-exemplified implementation instructions

Instruction format - with possible classification values: a) Textual format – with two possible values: i) Plain text only ii) Organized text b) Graphical format c) Tabular format
Research method – with possible classification values: 1) Conceptual modeling 2) Case studies 3) Surveys 4) Mathematical modeling
Knowledge origin – with possible classification values: 1) Academic knowledge 2) Empirical evidence 3) Academic knowledge and empirical evidence

In order to avoid redundancy classification dimension as well as their possible values will be defined and further explained in the Results section.

3. RESULTS

The 13 papers analyzed carefully via full text reading were classified based on (1) MC overview, (2) applicability context of the guidelines, (3) required resources, (4) as-is analysis tools, (5) hindrance factors, (6) instructions contents, (7) instruction exemplification, (8) instruction format, (9) research method and (10) knowledge origin.

In the remainder of the section classification dimensions from Table 2 will be defined, coding values provided with explanation and results of article analysis presented.

3.1. MC overview

MC overview is presentation of basic knowledge about MC concept. MC overview can provide MC definition, list of MC enablers, definitions of MC enablers, basic MC enabler relationships, overview of company's departments involved in the MC implementation, benefits derived from MC implementation and benefits derived from each MC enabler implementation.

According to MC overview relevant papers are classified as (Table 3):

1. MC overview provided – a case when at least simple MC overview is presented in the paper. Example of a simple MC overview is the one that contains MC definition and list of enablers.
2. MC overview not provided – a case when overview of MC concept is not presented in the paper. For example MC definition is provided in the paper, but other components like list of MC enablers, definitions of MC enabler etc. are not present in the paper.

Table 3. *Analysis of relevant papers according to MC overview*

Classification dimension	Categories	No. of papers
MC overview	MC overview provided	2
	MC overview not provided	11
Total number of papers		13

Results presented in Table 3 show that only 2 out of 13 relevant papers provide MC overview. Other 11 papers do not provide MC overview.

3.2. Applicability context of the guidelines

Applicability context of the guidelines takes into consideration the generalizability of the MC guidelines. Applicability context provides borders of validity for the proposed guidelines. For example, industry, type of products, size of the company etc. present applicability context of the guidelines.

According to the applicability context relevant papers are classified as (Table 4):

1. Applicability context listed and justified – a case when applicability context is stated accompanied by justification. Example is the case when it is stated that implementation guidelines are applicable in car industry followed by justification of why this is so.
2. Applicability context listed – a case when applicability context is provided but not-accompanied by justification. For example, it is stated that implementation guidelines are applicable in car industry, but without justification of why this is so.
3. Applicability context not explicitly stated, but self-evident – a case when applicability context is not addressed in the guidelines, but either way it is self-evident. Example is providing hardware products examples through whole paper, which makes it evident that applicability context is manufacturing and not the services sector.
4. Applicability context not discussed at all – a case when applicability context is not addressed in the guidelines. For example, guidelines are provided, but without explicitly or implicitly providing the industry they are applicable to.

Table 4. *Analysis of relevant papers according to applicability context of the guidelines*

Classification dimension	Categories	No. of papers
Applicability context of the guidelines	Applicability context listed and justified	2
	Applicability context listed	1
	Applicability context not explicitly stated, but self-evident	9
	Applicability context not discussed at all	1
Total number of papers		13

Results presented in the Table 4 show that only 3 out of 13 papers provide applicability context explicitly. Applicability context is listed and justified for construction and software industry (2 papers), while applicability context is only listed for service industry (1 paper). Another 9 papers implicitly provide manufacturing industry context through examples used throughout the paper. One paper only does not discuss applicability context at all.

3.3. Required resources

Required resources are resources needed to implement MC or one or more of MC enablers to certain extent. Example of resources required are financial resources for MC implementation, time needed for the MC implementation, human resources required for the MC implementation etc.

According to the resources required relevant papers are classified as (Table 5):

1. Required resources addressed – a case when resources needed to implement MC are stated. Example of required resources for MC

implementation is time needed to conduct product modularization in one's company.

2. Required resources not addressed – a case when resources needed to implement MC are not stated. For example implementation instructions for form postponement and product configurator can be provided, but without stating time, cost or human resources that are needed in order to reach this implementation.

Table 5. *Analysis of relevant papers according to required resources*

Classification dimension	Categories	No. of papers
Required resources	Required resources addressed	4
	Required resources not addressed	9
	Total number of papers	13

Results presented in Table 5 show that minority of the papers (4 out of 13) addresses resources required for the implementation. Rest of the papers (9 out of 13) does not address required resources.

3.4. As-is analysis tools

As-is analysis tools support assessment of the current company situation against the future MC implementation challenges. They can be in the form of procedures, formulae, templates etc.

According to the as-is analysis tools relevant papers are classified as (Table 6):

1. As-is analysis tools provided – a case when tools to support assessment of the current company situation are provided. Example of as-is analysis tool is a set of formulae to measure current level of part similarity within product families.
2. As-is analysis tools not provided – a case when tools to support assessment of the current company situation are not provided. Example is when guidelines do not take into account current company situation.

Table 6. *Analysis of relevant papers according to as-is analysis tools*

Classification dimension	Categories	No. of papers
As-is analysis tools	As-is analysis tools provided	3
	As-is analysis tools not provided	10
	Total number of papers	13

Results presented in the Table 6 show that great majority of the papers (10 out of 13) does not provide as-is analysis tools. Only 3 papers all together provide as-is analysis tools.

3.5. Hindrance factors

Hindrance factors are variables that negatively affect MC implementation. They can appear in the form of various obstacles, challenges, barriers, resistance to change, etc.

According to hindrance factors relevant papers are classified as (Table 7):

1. Hindrance factors provided – a case when guidelines provide variables that negatively affect MC implementation. Example of hindrance factor is resistance to change that can appear in managers and employees towards change process and implementation of new practices in everyday work.
2. Hindrance factors not provided – a case when guidelines do not provide variables that negatively affect MC implementation. Example is providing detailed implementation instructions for product modularization and form postponement, but without stating what factors could hinder this implementation.

Table 7. *Analysis of relevant papers according to hindrance factors*

Classification dimension	Categories	No. of papers
Hindrance factors	Hindrance factors provided	2
	Hindrance factors not provided	11
	Total number of papers	13

Results presented in the Table 7 show that great majority of the papers (11 out of 13) do not provide hindrance factors for MC implementation. Only 2 papers do provide hindrance factors for MC implementation.

3.6. Instruction contents

Merriam-Webster Online dictionary defines instruction as:

1. "a statement that describes how to do something" or
2. "the action or process of teaching: the act of instructing someone"[2]

For the purposes of the research we broaden first Merriam-Webster definition and define *implementation instructions* as: anything that describes how to do something. In our case, this "doing something" reads "implementing MC".

Instruction contents define the scope of the provided implementation instructions. Scope of the implementation instructions can be one or more than one enabler. Depending on their scope implementation instructions will differ substantially.

According to the instruction contents we can have:

1. Single enabler implementation instructions
2. Multiple enabler interdependence implementation instructions

Single enabler implementation instructions are detailed implementation instructions focused on one enabler. These instructions provide enough details to make them usable as guidance to implement specific enabler in practice.

According to single enabler implementation instructions relevant papers are classified as (Table 8):

1. Single enabler implementation instructions provided – a case when detailed implementation instructions are provided for a specific enabler. For instance, "in order to modularize product portfolio all components should be identified, clustering of components into modules should be done, interfaces between modules defined…" is an example of the single enabler implementation instructions.
2. Single enabler implementation instructions not provided – a case when detailed implementation instructions are not provided for a specific enabler. For instance, relations of product modularization with other enablers could be defined in the article, but without providing detailed implementation instructions for any of considered enablers.

[2] http://www.merriam-webster.com/dictionary/instruction

Table 8. *Analysis of relevant papers according to single enabler implementation instructions*

Classification dimension	Categories	No. of papers
Single enabler implementation instructions…	provided for 7 or more enablers	0
	provided for 6 enablers	1
	provided for 5 enablers	1
	provided for 4 enablers	0
	provided for 3 enablers	5
	provided for 2 enablers	6
	provided for 1 enabler	0
	not provided	0
Total number of papers		13

Results presented in the Table 8 show that all of relevant papers contain two or more single enabler implementation instructions (13 out of 13).

In order to understand better what enablers are crucial for the MC implementation a list of enablers has been derived from the analyzed papers. Enablers for which single enabler implementation instructions were provided in the analyzed implementation guidelines were taken into account. Table 9 shows these enablers and their frequency of appearance in the implementation guidelines.

Table 9. *List of used enablers in the relevant papers with frequency of appearance (based on single enabler implementation instructions provided)*

Enabler name	Frequency of enabler appearance in IG
Product platform development	9
Product modularization	9
IT-based product configuration	6
Part standardization	4
Group technology	3
Form postponement	2
Sourcing configuration for MC	1

Results presented in the Table 9 show that relevant papers provide implementation instructions for 7 enablers all together. Most significant enablers are Product platform development, Product modularization and IT-based product configuration, that appear in 6 to 9 articles. Other enablers appear in in 4 or less articles.

Multiple enabler interdependence instructions are implementation instructions that define relationships between two or more enablers. It can be relationship of precedence, encompassing, embedding etc.

According to multiple enabler interdependence implementation instructions relevant papers are classified as (Table 10):

1. Multiple enabler interdependence implementation instructions provided – a case when relationship between two or more enablers are defined. For instance, instructions can state that part standardization must precede product modularization in the implementation process.
2. Multiple enabler interdependence implementation instructions not provided – a case when no relationships between the enablers are defined. In this case paper can provide part standardization instructions and product modularization instructions but without relating these enablers in any way.

Table 10. *Analysis of relevant papers according to multiple enabler interdependence implementation instructions – with the number of enablers in relation and the way of presentation*

Classification dimension	No. of enablers in the relation	Way of presenting the relations in the paper		Total
		Explicit	Implicit	
Multiple enabler interdependence instructions	No enablers in the relation	0	2	2
	2 enablers in the relation	4	4	8
	3 enablers in the relation	0	2	2
	4 enablers in the relation	0	1	1
Total number of papers		4	9	13

Results presented in the Table 10 show that multiple enabler interdependence instructions are provided in great majority of the relevant papers (11 out of 13). Only 2 papers do not provide any information about multiple enabler interdependence. Multiple enabler interdependence implementation instructions were also analyzed depending on the way they are presented in the paper (Table 10). Instructions were categorized according to the number of enablers participating in the relation and explicitness of relation presentation. This analysis has shown that multiple enabler interdependence implementation instructions are mostly provided for two enablers (8 times) and three enablers (2 times) – Table 10. Only one paper provided multiple enabler interdependence implementation instructions for 4 enablers. Also, analysis has shown that most of the multiple enabler interdependence implementation instructions are provided implicitly (9 of 13 – Table 10).

3.7. Instruction exemplification

Instruction exemplification refers to providing an example of the implementation instructions application. Aim of the examples is to show how implementation instructions application would look like in practice.

According to the presence of example implementation instructions are classified as (Table 11):

1. Exemplified implementation instructions – a case when example of implementation instructions application is provided. For instance, example is a figure that presents grouped parts of products as a result of group technology application.
2. Non-exemplified implementation instructions – a case when example of implementation instructions application is not provided. For instance, group technology instructions can be provided without any examples of group technology application.

Table 11. *Analysis of relevant papers according to instruction exemplification*

Classification dimension	Categories	No. of papers
Instruction exemplification	Exemplified impl. instructions	11
	Non-exemplified impl. instructions	2
Total number of papers		13

Results presented in Table 11 show that great majority of the relevant papers provides examples for the implementation instructions (11 out of 13). Only 2 papers do not exemplify their instructions.

3.8. Instruction format

Instruction format refers to the way implementation instructions are organized and presented. According to the instruction format implementation instructions can be more or less well organized and presented. Level of organization and presentation of implementation instructions implies the level on which they have been thought on.

According to the format implementation instructions can be provided as (Table 12):

1. Textual format – can be:
   a. Plain text only – a case when instructions are presented in mere textual format without any kind of structure. Example of plain text instruction is a prescription or a story describing enabler implementation without organizing implementation activities in any way (no subtitles, bullet points, flow charts etc.).
   b. Organized text – a case when instructions are organized by bullet points, paragraphs or by sections, where every bullet point/paragraph/section provides instructions for one single activity at a time. Example would be a section that is dedicated to implementation of a single enabler that contains subsection dedicated to one implementation activity each.
2. Graphical format (flow chart, drawing, chart, diagram etc.) – a case when instructions are provided through visual presentation, e.g. in a form of a flow chart, drawing, chart, diagram etc. Example of graphical format would be providing a flow chart of activities needed to implement one enabler.
3. Tabular format – a case when instructions are given in a form of a table. Example for instructions given through a table could be comparative analysis of level of similarity of product families before and after the part standardization implementation done on product assortment.

Results presented in Table 12 show that majority of single enabler implementation instructions is presented through textual instructions (35 times in total). These textual instructions re given either through plain text (20 instances) or through organized text (15 instances). Other formats used for single enabler implementation instructions are graphical format (31 instances) and tabular format (12 instances).

Table 12. *Analysis of relevant papers according to instruction format*

Classification dimension	Categories	No. of single enablers impl. instructions provided in specific format*	No. of multiple enabler interdependence impl. instructions provided in specific format*
Instruction format	Plain text (Textual format)	20	3
	Organized text (Textual format)	15	8
	Graphical format	31	2
	Tabular format	12	0
Total number of instructions		34	11

**One implementation instruction can be provided in multiple formats. Thus, the total number of implementation instructions is smaller than the sum of all formats combined.*

Table 12 also provides information about format of multiple enabler interdependence implementation instructions which is majorly presented through textual format (11 times in total). These textual instructions are given through organized text (8 instances) and plain text (3 instances). Other formats used for multiple enabler implementation instructions is graphical format (2 instances). Tabular format is not used to present multiple enablers interdependence implementation instructions.

3.9. Research method

Research method is an important characteristic of a scientific contribution. This is even truer in the case of applied discipline where research addresses both academics and practitioners and where validity of research is judged upon its research method appropriateness.

Using established classification of research methods [42], [43] relevant papers have been classified as (Table 13):

1. Conceptual modeling (potentially including simple numerical examples)
2. Case studies, including multiple case studies
3. Surveys, based on questionnaires
4. Mathematical modeling (or simulation)

This classification was used both to classify:

1. Research method to build the implementation guidelines
2. Research method to assess the validity of the implementation guidelines

Table 13. *Analysis of relevant papers according to research method*

Classification dimension	Categories	CM	CS	S	M	NT
Research method	RM to build the IGs	12	1	0	0	N/A
	RM to assess the validity of the IGs	0	9	0	2	2

RM-Research method, CM-Conceptual modeling, CS-Case study, S-Survey, M-Math (or simulation), NT-Not tested

Results presented in Table 13 show that great majority of the relevant papers use conceptual modeling as method for building implementation guidelines (12 out of 13). Case study is used in one paper for building the implementation guidelines.

Table 13 also shows that majority of the papers (9 out of 13) use case study as research method to assess the validity of the implementation guidelines. Other method used is simulation (2 out of 13). Last 2 papers have not been tested for validity.

3.10. Knowledge origin

Knowledge origin defines the base of the implementation guidelines creation. Knowledge can be result of practical experience (empirical knowledge), result of analytical thinking (academic knowledge) or result of both combined.

According to the knowledge origin relevant papers can be classified as (Table 14):

1. Academic knowledge – a case when implementation guidelines are result of analytical academic thinking. Example of academic knowledge is providing implementation guidelines for product modularization, but only on the theoretical/mathematical basis, without relation to practical examples.

2. Empirical evidence – a case when implementation guidelines are result of practical experience. Example are implementation guidelines built upon a case study of manufacturing company that implemented product modularization on its product assortment.
3. Academic knowledge and empirical evidence – a case when implementation guidelines are result of both analytical academic thinking and practical experience. Example are implementation guidelines build upon theoretical knowledge of product modularization combined with the knowledge gained through case study of manufacturing company that implemented product modularization on its product assortment.

Table 14. *Analysis of relevant papers according to knowledge origin*

Classification dimension	Categories	No. of papers
Knowledge origin	Academic knowledge	3
	Empirical evidence	2
	Academic knowledge and empirical evidence	8
	Total number of papers	13

Results presented in the Table 14 show that majority of the papers uses both academic and empirical knowledge for implementation guidelines creation (8 out of 13). Academic knowledge only is used for development of implementation guidelines in 3 papers and empirical evidence only is base in 2 other papers.

4. DISCUSSION

Developing MC capability can be a demanding task for many companies. Some kind of guidance would be beneficial to make the path towards MC successful. This literature review was focused on analyzing the guidelines for MC implementation available in the literature. The present discussion is organized on the base of classification dimensions defined in the Literature review method section and further analyzed in the Results section.

4.1. MC overview

MC overview reduces practitioner efforts required to acquire basic knowledge of MC. MC is a wide and still growing research field that requires substantial effort to be grasped. MC overview reduces practitioner efforts needed to acquire knowledge regarding MC by presenting the essence of MC concisely and on limited space.

Results of analysis show that only 2 out of 13 papers contain MC overview (Table 3). So MC overview dimension is lacking in the relevant papers. We can argue that one reason for lack of MC overview is that task is very demanding, while second reason could be that researchers feel that this task has already been done by someone else etc. Either way, we can conclude that MC overview is characteristic of MC implementation guidelines that should be taken into account for the guidelines developed in the future.

4.2. Applicability context of the guidelines

Providing applicability context helps practitioners to understand whether implementation guidelines are applicable to their case. This is true even for the most basic listing of applicability context. Listing of applicability context implies that researchers have thought of the generalizability of the guidelines not leaving this thinking solely to the practitioners.

Results show that only 3 out of 13 papers provide explicit applicability context (Table 4). Thus applicability context is dimension lacking in the relevant papers. We can argue that some researchers do not find it necessary to list the applicability context like in the case of 9 papers that implicitly provide applicability context through nature of examples they provide (Table 4). In turn we can conclude that listing and justifying applicability context is characteristic of future developed MC implementation guidelines.

4.3. Required resources

Required resources provide practitioners possibility to estimate resources that are needed for the MC implementation. Even rough data about resources required can be of high value to the practitioners and can be used as a reference point.

Unfortunately, only minority of articles considers resources required for MC implementation (4 out of 13 papers – Table 5). Thus we can ascertain lack of resources required dimension in the relevant papers. We can argue that reason for not addressing resources required could lie in complexity of MC implementation that results with difficulties in addressing resources issue. We can conclude that required resources should receive more attention in the MC implementation guidelines that will be developed in the future.

4.4. As-is analysis tools

As-is analysis tools help practitioners to determine their companies position against the future MC implementation challenges. Usually starting positions of different companies will differ substantially depending on industry, size, human resources etc. As-is analysis tools provide a way to respect these differences in taking decision about future MC implementation activities.

Only 3 out of 13 papers propose as-is analysis tools for MC implementation (Table 6). Thus we can ascertain lack of as-is analysis tools in the relevant papers. We can argue that this absence of as-is analysis tools can be attributed to standing point of most of the research which deals with transformation from mass production (MP) to mass customization. Nevertheless, we can also argue that most of the companies moving towards MC will not start from pure MP but be somewhere in between MC and MP, or between craft production and MC. We can conclude that as-is analysis tools should be characteristic of future developed MC implementation guidelines.

4.5. Hindrance factors

Hindrance factors are important for practitioners since they provide additional knowledge for the MC implementation. While it is important to know what and how to implement, it is also of high importance to know what the variables that can slow/stop the implementation are. Knowing what hindrance factors are could help to successfully counter their effect.

Only 2 out of 13 papers provide hindrance factors (Table 7). Thus we can ascertain lack of hindrance

factors in the relevant papers. We can argue that focus on how to do something as opposed to what is slowing us in doing it is somewhat justifiable. Nevertheless, we can also argue that knowing hindrance factors in advance would have positive effect on MC implementation. Hence we can conclude that hindrance factors should be included as a part of MC implementation guidelines developed in the future as their characteristic.

4.6. Instruction contents

Instruction contents can be presented through:

Single enabler implementation instructions are crucial for practitioners since they save time and effort for implementation steps elaboration. This is because single enabler implementation instructions are detailed and thus require less work of practitioners in elaboration and specification of enabler implementation.

Single enabler implementation instructions are present in every relevant paper (13 out of 13 – Table 8). At first glance this is a good result of the research. But, analysis also showed that all together 7 enablers were recorded (Table 9), with most usual case of covering 2 or 3 enablers in one paper (Table 8). We can argue that this narrow research scope is usually consequence of researcher's previous experiences and opinion regarding most important enablers for MC implementation. We conclude that widening scope of the enablers addressed in future developed MC implementation guidelines should be set as a goal.

Multiple enabler interdependence implementation instructions are important for practitioners since they reduce efforts for MC implementation planning. Thus, these instructions can be used as MC implementation plan or its part by practitioners who can implement it as given or with some modifications.

Multiple enabler interdependence implementation instructions are present in 11 out of 13 relevant papers (Table 10). This is a good coverage, but deeper analysis shows that many of these instructions are provided mainly for a limited number of enablers – usually 2 or 3 (10 out of 11 times - Table 10). Analysis also showed that these instructions are usually implicitly given (9 out of 13 – Table 10). We can argue that usually no need is seen for making more explicit relations between enablers as they are regarded as obvious. In conclusion we can say that multiple enabler interdependence instructions should include more enablers and be given explicitly in the MC implementation guidelines developed in the future.

4.7. Instruction exemplification

Instruction exemplification is important for practitioners because it reduces efforts needed to understand the instructions. Exemplification enables practitioner to compare results of implementation with his own experience. In this way practitioner does not need to come-up with example by himself which in result reduces effort to correctly figure out how instruction can be applied in his specific context.

Instructions exemplification is provided in 11 from 13 papers (Table 11). This presents high coverage in the relevant papers. We can argue that this is due to knowledge transfer nature, where conveying ideas is more effective if provided with the example. In conclusion we can say that need for providing examples for implementation instructions has been recognized by researchers and is fulfilled in the relevant papers.

4.8. Instruction format

Organized text, graphical and tabular instructions are significant for practitioners since they are more understandable. Compared to the plain text instructions this kind of instructions are more organized and better presented leaving less chance for practitioner's misinterpretation. The to-do list emerges clearly.

Instruction formats are used in different proportions depending on the instruction contents. Single enabler implementation instructions have high use of plain text format (20 out of 34 – Table 12). Multiple enabler interdependence implementation instructions have high use of organized text (8 of 11), but low use of graphical format (2 out of 11 – Table 12) and do not use the tabular format (Table 12). We can argue that it is easier to provide instructions through a plain text than through organized text, graphical and tabular format. In conclusion we can say that organized text format, graphical and tabular format should be preferred in development of MC implementation guidelines in the future opposed to use of plain text format.

4.9. Research method

Research method is important also because knowing how implementation guidelines have been developed and validated could help practitioners to appreciate them. Practitioners will see some contribution as more trustable if it is backed up by case from practice.

Research showed that research method most frequently used for building of implementation guidelines is conceptual modeling (12 out of 13 – Table 13) and research method most frequently used for assessing the validity of implementation guidelines is case study (9 out of 13 – Table 13). We can argue that this combination is usually one leading to use of academic as well as practical knowledge in MC implementation. In conclusions we can say that research methods used by researchers are in line with needs for developing MC implementation guidelines.

4.10. Knowledge origin

Knowledge that has empirical origin reinforces the notion of practical applicability of the implementation guidelines for practitioners. Since practitioners are interested in practical implementation, empirical evidence derived from experience makes implementation guidelines more acceptable for application.

Knowledge origin is twofold (academic and empirical) in most of the relevant papers (8 out of 13 – Table 14). This high ratio of papers containing both academic and empirical knowledge is in some way expected since the research is done in applied discipline. We can argue that combining academic and empirical knowledge is recognized as a way to convey the knowledge to practitioners and validate developed implementation guidelines. In conclusion we can say that need for both academic knowledge and empirical evidence is recognized by the researchers for development of MC implementation guidelines.

5. CONCLUSIONS

The present paper reports a part of a comprehensive literature review on the topic of MC implementation. Research is still ongoing and further findings are expected. Thirteen relevant articles have been identified and deeply analyzed.

Of course, the present research has limitations, although authors hope to overcome part of these in the future. First, research by selecting articles on the basis of journal quality do not consider all relevant literature. Secondly, only Scopus database has been used for the literature search. Thirdly, research could go deeper with the analysis of the enablers and their relations. Nevertheless, even with these limitations, current ongoing research gives some interesting and important findings.

Although number of conclusions referring to the characteristics of MC implementation guidelines have been given in the Discussion section, rest of this section will provide other more general conclusions regarding the research.

Firstly, using classification dimensions of MC implementation guidelines we have been able to identify the characteristics of MC implementation guidelines, namely: MC overview, applicability context of the guidelines, required resources, as-is analysis tools, hindrance factors, instruction contents, instruction exemplification, instruction format, research method and knowledge origin.

Secondly, we can ascertain that from analysis of the relevant papers it is evident that not all of characteristics of MC implementation guidelines receive equal recognition. For some of the characteristics recognition is satisfactory (research method and knowledge origin), while other have only partial recognition (required resources), or have substantial lack in recognition (MC overview, applicability context of the guidelines, as-is analysis tools and hindrance factors). Some characteristics seem to have adequate recognition, but which could come in more appropriate form (instruction contents, instruction exemplification and instruction format). In sum we can say that provided implementation guidelines focus on enablers, usually not taking into account other characteristics of implementation guidelines. We can argue that MC implementation guidelines that will be developed in the future could benefit from using these characteristics in order to provide more complete implementation guidelines. We also argue that guidelines taking more of these characteristics into consideration would be more appreciated from the practitioner's side.

Future works should focus on developing of holistic MC implementation guidelines with purpose to help practitioners in making the right decisions on where to invest their human, capital and time resources to move closer to MC. These implementation guidelines should include MC overview, applicability context, required resources, as-is analysis tools, hindrance factors, adequate instruction contents and instruction exemplification. MC implementation instructions provided should be grounded in academic knowledge as well as empirical evidence in order to adequately respond to practitioner's needs.

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