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Organizing for Mass Customization: Literature Review and Research Agenda

Enrico Sandrin
PhD candidate, Department of Management and Engineering, University of Padova, Stradella S. Nicola, 3, 36100 Vicenza, Italy, sandrin@gest.unipd.it
Alessio Trentin
Assistant professor, Department of Management and Engineering, University of Padova, Stradella S. Nicola, 3, 36100 Vicenza, Italy, alessio.trentin@unipd.it
Cipriano Forza
Full professor, Department of Management and Engineering, University of Padova, Stradella S. Nicola, 3, 36100 Vicenza, Italy, cipriano.forza@unipd.it

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Abstract

Due to the increase in sophisticated customer needs and intense competition, mass customisation has increasingly drawn the attention of companies and scholars. The importance of transforming organisations by building mass customisation capability has long been acknowledged. However, the discussion is generally scattered and disorganised in the literature. This paper reviews the mass customisation literature with the twofold purpose of providing a comprehensive and structured overview of prior research on mass customisation organisational antecedents and highlighting future opportunities to research this topic. By using an established framework in the organisation design theory, the paper provides comprehensive coverage of organisation-related issues and a reference for future research opportunities.

Key words: *literature review, mass customization, organization design.*

1. INTRODUCTION

As customers nowadays are less and less willing to buy a “one size fits all” product and competitive pressure is intensifying, mass customisation (MC) is becoming an increasingly widespread concern among companies [1, 2]. MC is the ability to provide customised products and services that fulfil each customer’s idiosyncratic needs without considerable trade-offs in cost, delivery and quality [3, 4]. Both the growing number of adoptions by firms of MC strategies [5] and the considerable increase in academic publications on MC during the last two decades confirm the relevance of this topic [6, 7].

The importance of transforming organisations to pursue an MC strategy has been acknowledged since the introduction of the MC concept [3]. Additionally, the organisational change has been recognised as one of the most important difficulties companies experience in implementing customisation [8-10], but organisational change is a necessary route to building the capabilities required by MC [11-13]. However, relatively less attention has been paid to the organisational antecedents of MC [4, 9, 14], as compared with its technological enablers [7].

This paper reviews the MC literature with the twofold purpose of providing a comprehensive and structured overview of prior research on MC organisational antecedents and highlighting future opportunities to research this topic.

2. LITERATURE REVIEW METHOD

Consistent with our aim of providing a comprehensive and structured overview of prior research on MC organisational antecedents, we followed a deductive approach in selecting and analysing the body of literature. This means that search keywords within all relevant databases and content classification criteria were chosen based on an *a priori* defined framework. For our reference framework, we used Galbraith’s [15] Star Model, which identifies five categories of organisation design variables: strategy, structure, processes, rewards and people (Figure 1).

The search for related publications was performed on the following scientific databases: Scopus, EBSCOhost, Web of Science, JSTOR and Wiley. The search was conducted using the Article Title and Abstract fields always, as well as the Keywords field where allowed. Except for JSTOR, the search terms used were “mass custom*” in combination with at least one of the following terms: “strateg*”, “structure*”, “process*”, “reward*”, “people” and “organi*”. As JSTOR does not support such complex search phrases, we decided to

conduct a broader search on that database using the following search phrases: title="mass customization#" OR abstract="mass customization#". The database searches were not limited by others criteria, such as Date Range, Document Type or Subject Areas.

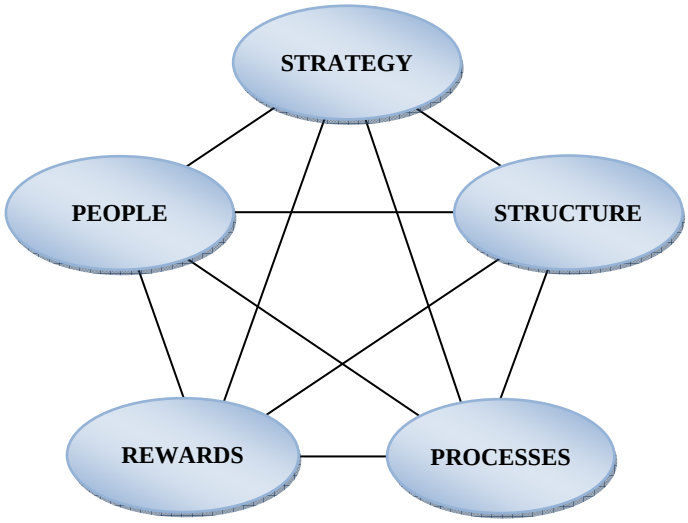

Figure 1. Galbraith's Star Model [15]

The databases search provided 4,196 publications (1,931 from Scopus, 655 from EBSCOhost, 1,518 from Web of Science, 30 from JSTOR and 62 from Wiley). These publications were imported in Endnote. The first cleaning step involved removing duplicates automatically with the Endnote command "Find Duplicates". The number of publications after this first cleaning step was 3,469, but this number still included many duplicates that were identified during the subsequent cleaning step based on abstract reading. The subsequent analysis was focused only on papers in peer-reviewed scientific journals; therefore, other publication types were not considered.

Because of this second cleaning step, many publications that are clearly beyond the scope of the study were excluded, and 152 publications were selected for full text reading. After full text reading, 66 papers were included in the analysis. In addition, references cited in these papers were used as secondary sources. This led to the inclusion of only eight additional relevant publications, which can be taken as an indication of the comprehensiveness of the initial set of papers.

The final set of 74 publications was subsequently classified. In general, coding categories for the classification of the reviewed literature can be derived deductively or inductively [16, 17]. Using a deductive approach, categories are chosen before the material is analysed, while for an inductive approach, categories are developed from the selected material [16, 17]. In this paper, we opted for a deductive coding approach using the five categories of organisation design policies included in Galbraith's [15] Star Model to classify prior research results (Table 1).

Table 1. Categories for classification

CATEGORIES	SUBCATEGORIES
STRATEGY	• Strategy
STRUCTURE	• Specialization • Distribution of Power • Shape • Departmentalization
PROCESSES *Information and Decision Processes*	• Vertical Processes • Lateral Processes
REWARDS	• Reward System • Metrics
PEOPLE	• Recruitment and Selection • Training and Development

Of note, in Galbraith's [15] view, processes are the information and decision processes that overcome the internal boundaries, as well as provide collaboration across these boundaries and the integration of activities.

3. RESULTS

3.1 MC strategy

In Galbraith's [15] Star Model, the choice of organisational strategy is the first and most fundamental decision that drives all other choices in the organisational design. According to Galbraith [15], a company's strategy sets the basic direction of the company; it specifies the goals and objectives to be achieved, as well as the values and mission to be pursued.

While the basic idea of any MC strategy is to combine high performance in product customisation with high performance in cost, delivery and quality, different MC strategies can be distinguished based on the degree of product customisation that a firm aims to provide [1, 3, 18-22]. The degree of product customisation is related to the point of initial customer involvement along the value chain, where a higher degree of product customisation means that customers are involved at an earlier stage of the value chain [1, 3, 18-22]. The degree of product customisation is, therefore, a key decision when a company decides to pursue a mass customisation strategy [6]. By combining some of the MC strategy typologies based on the degree of product customisation [3, 18-20], Da Silveira, Borenstein and Fogliatto [6] generated eight MC levels, ranging from pure customisation to pure standardisation (i.e. no customisation). Duray, Ward, Milligan and Berry [23] added another dimension to the classification of MC strategies by developing a two-dimensional framework that considers both the point of customer involvement and the type of product modularity. The same classification criteria were applied by Bask, Lipponen, Rajahonka and Tinnilä [24] to MC strategies in the service industry. MacCarthy, Brabazon and Bramham [25] further enriched the debate by distinguishing five

fundamental MC modes based on the characteristics of six fundamental operational processes for MC. Ross [21] also looked at the MC strategy from another perspective: by distinguishing three MC types depending on the product features that can be customised (i.e. cosmetic, selectable functional options, core customisation). A similar perspective was adopted by Piller [26] (i.e. style or aesthetic design, fit or measurements and functionality). Gilmore and Pine [19] combined, in their framework, the type of customer involvement with the type of product features that are customised.

Even though the debate on the types of MC strategies is lively, most organisational studies on MC have overlooked this fundamental contingency variable. The type of MC strategy should therefore be included in future studies on MC organisational antecedents.

3.2 **Organisational structure for MC**

According to Galbraith [15], organisational structure determines the location of the authority and power in the organisation. There are four categories of structure policies: specialisation, shape, distribution of power and departmentalisation.

Specialisation. It concerns the types and numbers of specialties to be used in performing work [15]. Having multi-functional employees is important for MC [4, 14, 27-30]. Employee multi-functionality is related to the enlargement of the jobs performed by employees, who should be capable of performing a diverse range of tasks beyond their immediate functional specialisation. Multi-functional skills are necessary for employees to appropriately respond to the increased uncertainty in the environment, as well as to the increased complexity in the production system that characterises MC [4]. In particular, the jobs of shop-floor employees should be enlarged to include maintenance of the equipment [4, 14]. This improves MC capability by enabling the timely control of variances and reductions in operational disruptions, as shop-floor employees have the best knowledge about operating problems and can control variances at their origins [4]. Specialisation should also be reduced in the production planning process, as combining the two roles of master production scheduler and materials requirement planner improves the organisation's ability to quickly respond to unforeseen changes in customer demands [29]. In addition to the enlargement of existing roles, MC can also require the creation of new roles within the organisation, such as those in charge of the development and maintenance of a product configurator [31-33].

Shape. It is determined by the number of hierarchical levels and the number of people forming departments at each hierarchical level. More people per department leads to fewer levels. The number of people in a department is usually referred to as the span of the control of the department manager [15]. The flatness of an organisational structure plays an important role in building MC capability [27, 34, 35] because deep organisational hierarchies with many layers reduce effective and timely communication and cooperation. In an MC environment, the number of unforeseen requirements arising from frequent changes needs faster communication and authority responses. Flatness enhances effective communication and timely cooperation [27].

Distribution of power. It refers to the distribution of decision-making power and authority [15]. Employees should be empowered to achieve the flexibility and responsiveness required by MC [4, 14, 30, 37]. For example, the practice of autonomous equipment maintenance by shop-floor employees, which increases MC capability [4, 14], also includes an aspect of job enrichment, as shop-floor employees are empowered to make autonomous decisions regarding their jobs. However, the decentralisation of operation authority may be insufficient. According to Boynton, Victor and Pine [38] and Kakati [39], an MC system should be made up of a dynamic network of modular and flexible processing units coordinated by a central decision-making unit. Therefore, the decentralisation of the operational authority within the process unit module should be combined with the centralisation of the coordination and control in the hub of loosely coupled processing units [38, 40]. In particular, Park and Nahm [41] suggest that the optimal level of the (de)centralisation of the decision-making authority is contingent on the degree of customisation offered by a mass customiser and the levels of modularity of its products. By referring to the R&D activities for MC, Magnusson and Pasche [42] suggest that decision making should be centralised in relation to product platform development and decentralised in relation to product modularisation.

Departmentalisation. It refers to the choice of departments to integrate specialised work, as well as to form a hierarchy of departments. Departments are usually formed to include people working in one of the following areas: a function or specialty, a product line, a customer segment, a geographical area or a workflow process. Each of these structures has its own strengths and weaknesses. Weaknesses can be overcome with hybrid structures and lateral processes [15]. Previous research suggests that MC capability is enhanced by the adoption of output-based departmentalisation criteria instead of input (or resources)-based criteria. By creating organisational sub-units focused on specific outputs and by giving them all the resources they need to supply the output, an organisation reduces information-processing needs, thus lowering coordination costs and increasing responsiveness [14]. This is well exemplified by cellular manufacturing, which enables firms to improve both cost effectiveness and the responsiveness of product customisation [4, 43, 44]. An ad-hoc organisational sub-unit (or a unit detached from the corporate organisation) could be considered for the maintenance of the information technology (IT)-based product configuration system [45].

To summarise, according to Huang, Kristal and Schroeder [27], an organic structure (characterised by the flatness and decentralisation of decision-making, as well as multifunctional and empowered employees) seems suitable for MC companies. The most important consequence of an organic structure is to enhance

organisational flexibility [46]. Flexibility is necessary to cope with the internal manufacturing complexity and the environmental turbulence that characterise MC companies [47]. However, when distinguishing between full mass customisers (which provide customisation at the design or fabrication stage) and partial mass customisers (which provide customisation at the assembly or delivery stage), Huang, Kristal and Schroeder [27] found empirical support for the positive relationship between organic structures and MC capability only in the case of full mass customisers. The importance of using a contingency approach is stressed by Liu, Shah and Schroeder [4] as well, when they discuss the lack of empirical support for the positive relationship between employee empowerment and MC capability in their study. They suggest that empowerment initiatives should be designed using a contingency approach instead of a universalistic one, because its effectiveness depends on business strategy, leader characteristics and the environment.

3.3 **Information and decision processes for MC**

Information and decision processes can be classified as vertical and horizontal (or lateral) processes. The former classification deals with the allocation of scarce resources, such as funds and talent, while the latter enables joint decision-making across functional boundaries [15]. An important role in both horizontal and vertical processes is played by IT.

Vertical processes. These processes allocate the scarce resources of funds and talent. Vertical processes usually include business planning and budgeting processes [15]. MC literature related to business planning and budgeting processes is still scarce and only deals with manufacturing planning processes [7]. Some authors proposed a number of quantitative approaches and techniques to allocate manufacturing resources to enhance flexibility, responsiveness and efficiency in manufacturing [e.g. 48, 49-51]. A recent advancement [52, 53] proposes to abandon the traditional approach to "configure the product then plan its production" in favour of a joint optimisation of both product configuration and production planning by exploiting the customer flexibility regarding some product characteristic requirements. In addition, insufficient responsiveness and flexibility in the production planning process may hinder the application of form postponement [29, 54-56], thus lowering operational performances needed for MC [57, 58]. Finally it has been recognised than even the choice of production planning methods is a contingent choice, as it is influenced by the point of customer involvement [59].
Though not related to the allocation of scarce resources, another result regarding vertical information flows is the importance of providing timely and accurate quality and process information and feedback to shop-floor employees [4]. This enables fast manufacturing process variance detection and correction, as well as provides opportunities for continuous improvement [4].

Lateral processes. They are information and decision processes that coordinate activities across different organisational units and increase the amount and frequency of communications across pre-existing departmental boundaries, providing mechanisms for decentralising general management decisions [15]. There are five basic types of lateral processes and they vary in the amounts of management time and energy involved: informal or *voluntary* lateral processes, *e-coordination*, *formal group*s, appointment of *integrator*s to lead full time the formal group and *matrix organisation* [15]. The need for internal integration is essential for MC because integration breaks down the functional silos to facilitate coordination across different organisational units, as well as increases the amount and frequency of communications across pre-existing departmental boundaries, which leads to a more connected and coordinated response to environment changes and disruptions [35, 60, 61]. Previous studies suggested that internal integration is crucial in the new product development process to achieve higher degrees of product modularity [36, 62-64] and form postponement [65-67]. Integration mechanisms are also crucial in an MC manufacturing system [63, 68], because modularity in production creates a dispersed assembly system that requires coordination [68]. Tu, Vonderembse, Ragu-Nathan and Ragu-Nathan [69] found that MC capability is predicted by the practice of dynamically reorganising manufacturing teams quickly and linking them to necessary resources in response to product design or manufacturing process changes. A typical approach to lateral coordination both in manufacturing and new product development processes is the use of teamwork. Brown and Bessant [37] found that teamwork is largely adopted by companies with an MC manufacturing strategy in place. Teamwork facilitates joint problem-solving efforts by bringing together different points of view, knowledge and skills from individual team members. The use of small groups for solving production problems is an important practice for quality management and, therefore, for MC [70]. More generally, the use of lateral relations increases MC capability by providing mechanisms for decentralising general management decisions, quickly using information where it exists, solving problems where they occur and improving the ability to adapt to a dynamic environment, such as an MC environment [14, 29].

IT support to vertical and lateral processes. The IT organisational infrastructure is crucial for coordination purposes in a changing environment, such as an MC environment [71-75]. In the dynamic network of modular and flexible processing units described by Boynton, Victor and Pine [38], a vertical IT-based system permits the central coordination and evaluation of product and process capabilities without interfering with local responsiveness. It also allows the firm to maintain global and decentralised operations because local and specific information can be transmitted in a universal language rapidly and accurately to senior managers to increase the speed of decision-making. IT systems play an important role in supporting horizontal processes, as well. In particular, IT-based product configuration systems contribute to increasing the effectiveness and

efficiency of customer order acquisitions and fulfilment processes, as well as offers mass customisers a way to codify product knowledge otherwise retained by individual employees [31]. IT-based product configuration systems enable a more efficient use of the knowledge in an organisational unit by modelling the knowledge into a product model and making it available to other organisational units [32, 45]. In addition, IT support for new product development increases MC capability by facilitating a modular product design [76].
With regard to information and decision processes for MC and enabling IT, however, a contingency perspective is lacking altogether. For example, different types of lateral processes can be used for coordination purposes [15], and future research could investigate which types of lateral connections are most appropriate according to the pursued MC strategy. Another research opportunity is to investigate the role of business planning and budgeting processes in the pursuit of MC.

3.4 **Rewards for MC**

Reward systems and related metrics aim to align individual behaviours and performances with the organisation's goals [15].

Reward system. It motivates employees and reinforces behaviours that add value to the organisation through policies, such as regulating salaries, bonuses, stock, recognition and benefits [77]. A reward system that aligns people toward plant goals and recognises the differential contributions of people in pursuing the plant strategy seems to be essential to MC [4]. In an MC environment, a reward and incentive system should motivate shop-floor employees to grasp multiple skills [4]. In addition, compensation and incentive practices should be based on team performance and company performance, aside from individual performance [30]. Finally, a structure of pay that encourages and supports numerical flexibility—that is, the readiness with which the number of persons employed can adjust to fluctuations in demand—is also important [39].

Metrics. They are the measures used to evaluate individual and collective performance [77]. While a few measures of MC capability at the organisational level are available in the existing MC literature [43, 78, 79], no contribution can be found in the literature regarding metrics specifically designed in relation to reward systems in an MC environment.

3.5 **People for MC**

The appropriate combination of human resource policies produces the talent required by the organisation, generating the skills and mind-sets necessary to implement its chosen direction and to build organisational capabilities to execute the strategic direction [15]. In this study, two main categories of human resource policies are used: recruitment and selection, on the one hand, and training and development, on the other hand.

Recruitment and selection. According to Armstrong [80], recruitment is the process of finding and engaging people in the organisation's needs, and selection is the part of the recruitment process concerned with deciding which applicants or candidates should be appointed to jobs. High standards for recruiting have a positive impact on MC capability [4]. This type of recruiting is based on an effective interview instrument and it aims to select employees who have work values, particular attitudes and the competencies of teamwork, problem solving, initiative and organisational commitment, in addition to technical and task-related competencies. It ensures that shop-floor employees are able to efficiently perform the complex and flexible manufacturing tasks that characterise MC contexts [4].

Training and development. According to Armstrong [80], development is concerned with ensuring a person's ability and potential are grown and realised through the provision of learning experiences or through self-managed learning. It is an unfolding process, which enables people to progress from a present state of understanding and capability to a future state in which higher-level skills, knowledge and competencies are required. Training involves the application of formal processes to impart knowledge and help people to acquire the skills necessary to perform their jobs satisfactorily [80]. The MC literature suggest that training should focus mostly on employee multi-functionality, adaptability and agility [2, 4, 14, 27, 37, 39] to help employees perform well in complex and flexible environments. In addition to cross-functional training, having employees highly skilled in their job is also important for MC [4, 81]. To that end, task-related training is needed to provide employees with technical skills, trouble-shooting capabilities and appropriate knowledge about the equipment and processes. In particular, enhancing technical skills increases the likelihood that operators will be able to offer meaningful suggestions to improve how work is conducted [4]. Learning should be organised on an on-going base [4, 37, 39] to shape a learning organisation that can adapt quickly to a changing environment [2, 82, 83].
With a more comprehensive view of human resource policies, finally, Leffakis and Dwyer [30] develop and test hypotheses of the most appropriate manufacturing human resource management systems for full and partial mass customisers, respectively. Specifically, they argue that an innovative bundle of human resource management practices, such as sophisticated pre-hire screening devices, realistic job previews, supervisory and administrative training and interpersonal and communication training, is more appropriate for full mass customisers. Conversely, traditional practices, such as formally structured interviews, horizontal cross training and training that ensures conformance to pre-set standards, are more suitable for partial mass customisers. Their empirical study supports the latter hypothesis, but not the former.

4. DISCUSSION AND CONCLUSION

The present paper analyses prior research findings on the organisational antecedents of MC through the lens of Galbraith's [15] Star Model, and it complements the results of previous literature reviews on MC. Da

Silveira, Borenstein and Fogliatto [6] identify required conditions and situations suitable for the adoption of MC, as well as discuss the fundamental principles and concepts of the MC theory. The enablers of MC implementation are grouped in processes and methodologies (agile manufacturing, supply chain management, customer-driven design and manufacture, lean manufacturing) and technologies (advanced manufacturing technology, communication and networks technology). In updating their previous literature review, the same authors indicate the use of web-based tools (e.g. product configurators), rapid manufacturing technologies and more structured interactions with customers as the major developments in the MC literature over the last decade [7]. Kumar, Gattoufi and Reisman [84] provide a statistical trend analysis of the MC literature, propose three taxonomic frameworks for classified MC research studies and distil three distinct elements that characterise MC: modular design, finite solution space and customer co-design. Ferguson, Olewnik and Cormier [85] explore the state-of-the-art in MC through the lens of the design process, which is broadly divided into three categories: marketing, engineering and distribution.

By classifying previous research results according to the five dimensions of organisation design included in Galbraith's [15] Star Model, the present literature review highlights prior research focused on organisational structure variables and lateral coordination mechanisms. Relatively less attention has been paid to human resource policies, rewards systems and metrics for MC.

Another major gap in the existing MC literature emerges if we consider the fundamental idea behind Galbraith's [15] Star Model. The basic tenet of Galbraith's [15] Star Model is that for an organisation to be effective, all its policies regarding organisational structure, information and decision processes, rewards and people must be aligned with the selected strategy. However, different types of MC strategies can be pursued. Even though the debate on the types of MC strategies is lively, most organisational studies on MC have overlooked this fundamental contingency variable. The type of MC strategy should therefore be included in future studies on MC organisational antecedents. This is even more necessary in light of the results of the few studies that include the type of MC strategy in their analysis. In particular, Huang, Kristal and Schroeder [27], in their empirical study, find that certain organisational design solutions that support full MC do not support partial MC.

Even though some of the works included in the present review recognise the limitations of not considering contextual contingency variables [e.g., 4, 69], the focus on contextual contingencies is still lacking in the current research dealing with the organisation design for MC. However, it would be important to consider contextual factors, as they could moderate some relationships between relevant variables for MC. For example, the difficulty of the market needs determination weakens the effect of product configurator use on product quality [86]. In addition, higher levels of demand uncertainty and competitive intensity augment the effect of the internal integration on customer integration, which is essential to building MC capability [60].

While contributing to the MC literature by synthesising prior research results into an integrative model and by outlining new research directions based on the unexplored areas of the integrative model, the present paper is not without limitations. Prior research results concerning inter-organisational level enablers of MC have remained out of the scope of this study. However, the peculiar relationships that an MC organisation must build with its customers to satisfy their idiosyncratic needs [87], as well as with its suppliers to build a robust and agile supply chain [88], require peculiar inter-organisational solutions [e.g., 89, 90, 91]. A further research opportunity is therefore to enlarge the scope of the present review to include inter-organisational-level enablers of MC.

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Organizovanje za kastomizovanu industrijsku proizvodnju: Literaturni pregled i istraživačka agenda

Enrico Sandrin, Alessio Trentin, Cipriano Forza

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Rezime

Usled uvećanja prefinjenih potreba potrošača i povećane konkurencije, kastomizovana industrijska proizvodnja privlači sve više pažnje kompanija i naučnika. Važnost organizacione transformacije izgradnjom sposobnosti koje omogućavaju kastomizovanu industrijsku proizvodnju je već dugo priznata. Međutim, diskusija je neorganizovana i rasuta po literaturi. Ovaj rad vrši pregled literature posvećene kastomizovanoj industrijskoj proizvodnji sa dvojakim ciljem obezbeđivanja sveobuhvatnog i struktuiranog pregleda prethodnih istraživanja preduslova za kastomizovanu industrijsku proizvodnju i naglašava buduće mogućnosti za istraživanje ove teme. Korišćenjem utvrđenog okvira teorije projektovanja organizacije, rad sveobuhvatano pokriva organizaciona pitanja i pruža referencu za moguća buduća istraživanja.

Ključne reči: *literaturni pregled, kastomizovana industrijska proizvodnja, projektovanje organizacije.*