

MASS CUSTOMIZATION AND GLOBAL PRODUCTION NETWORKS – CHALLENGES FOR EAST EUROPEAN INDUSTRIES

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Abstract:

Since the collapse of the iron curtain between Eastern and Western Europe, economic ties like trade relations and foreign direct investments have underpinned the political integration of the countries. Though strong regional disparities still exist, most national economies of Eastern Europe have grown considerably in recent years. Using a geographical lens and key concepts of economic geography, the paper analyses what kind of consequences a stronger implementation of mass customization in the German capital goods industry, which contributes considerably to the export success of the German economy, would have for East-European industries.

Key Words: Mass Customization, Global Production Networks, Clusters, Capital Goods Industry, Eastern Europe, Germany

1. INTRODUCTION

In addition to the political integration of the European countries, which mainly occurred through the European Union, an economic integration took also place after the downfall of the iron curtain in the years 1989/1990. Driver of the economic integration have been foreign direct investments and trade relations between the formerly divided Eastern and Western countries. It was and is an opportunity for companies from Western Europe to have countries nearby which offer a qualified workforce at reasonable costs and also consumers for their products. For German industrial firms, the new member countries of the European Union were the favourite locations for foreign direct investments (FDI) from 2001 until 2006, even before China. 62% of the industrial firms, which invested directly abroad, did that in the new member countries. Through the proximity to these countries German firms were able to shift production facilities and, at best, to improve the cost structure and increase the sales through their entry into new national markets [1].

At the same time it is an advantage for the countries of Eastern Europe to be located close-by to a huge market and a well developed industrial region: through the direct investments of Austrian, German or French firms they gain capital as well as know-how as contributions to their development paths, a process theorized through the concept of global production networks, presented in the next chapter.

But not all of the German firms are successful with their engagement abroad. For example, one out of approximately five German firms, which invested abroad, closes down or downsizes the factory over the period of five years after the investment and relocates parts or the whole production back to Germany. Especially losses regarding quality and flexibility induce firms to relocate production facilities. The relocation rate from Eastern Europe is particularly high – 39% of the relocating firms had invested in the region. The authors of the study from the Fraunhofer Institute for Systems and Innovation Research assume that firms do assess an investment in China much deeper than one in Romania or in the Czech Republic. An investment decision regarding China is only taken when the success appears to be guaranteed. Another reason might be the fact that investment decisions regarding Eastern Europe are primarily encouraged by the low labour costs. In China the market entry argument outranks the labour cost factor [2].

The study also detects a decline in the investment propensity of German firms. On the one hand this might be a result of the process that Germany has become much more attractive for investors in recent years from a cost-perspective: labour costs in Germany have become more competitive in 2007 as they have only increased by 1 percent.¹ In the European Union they have increased by 3.4 percent, in Romania even by 30.2 percent. Of course the range of labour costs between, for example, Germany and Romania remains high, but the gap is gradually narrowing [3]. On the other hand the decline might be a product of a too enthusiastic appraisal of the prospects abroad in the past and an undervaluation of the problems in organizing production in a different national context [2].

The last argument is an important one for a firm which assembles complex products and is dependent on a high quality input from workers as well as suppliers and service firms. Mass customization is such a strategy. As a customer-centred production strategy it has multiple advantages for firms: they differentiate themselves from competitors, improve their image as innovative firms and have the possibility to save costs through the utilization of economies of scale, scope, integration and interaction [4, 5, 6]. But the process of implementing a mass customization strategy is a complicated one and depends heavily on firm-internal and -external factors. At first glance a spatial division of labour – in the sense that a capital goods producer assembles labour-intensive modules in Eastern Europe – or imports these from a Romanian or Polish supplier – seems to be an attractive option. But, as will be shown in this article, mass customization in the capital goods industry is better suited to be organized in local or regional clusters.

This paper deals with the questions on how a stronger implementation of mass customization strategies in the capital goods industries of Western European countries like Germany could change the existing patterns of production and the industrial division of labour in Europe. It analyses the factors of a successful implementation of a mass customization strategy from a spatial perspective. The arguments have been derived deductively and therefore can be seen as hypotheses which could form the foundation of an empirical analysis.

This article is organized as follows. I first present some figures which underscore the economic integration of Eastern and Western European countries using the example of Romania. Next, I focus on the delineation how regions can benefit from linkages to global production networks and discuss the influence of cultural differences on an efficient coupling between local and foreign firms. Then, I pinpoint why a multinational production context hampers the implementation of a mass customization strategy and why this can be organized more efficiently in clusters. Finally, I summarize the findings and make some concluding remarks.

2. EXTERNAL TRADE AND FOREIGN DIRECT INVESTMENT IN EASTERN EUROPE – THE CASE OF ROMANIA

To document the claim made in the introduction that the countries of Eastern and Western Europe nowadays are economically deeply interwoven, this chapter focuses on the external trade structure and particularly on the foreign direct investments in Romania, which entered the European Union in January 2007.

The foreign trade volume of Romania added up to around 66 billion € in 2006. The imports have exceeded the exports by around 15 billion €. Main import and export commodities with a proportion of around 35% respectively were preliminary industrial products. This already points at the importance of intraindustrial trade linkages for the country. The main trade partners of Romania are countries from the European Union. They have accounted for around 70% of the trade volume in 2006 [7].

¹ The development of the unit labour costs underlines the increased competitiveness of Germany. Whereas in Germany they have decreased slowly between the years 2004 and 2006 they have increased in the European Union by around 1.5% per year [53], in Romania even by 34% in 2006 alone [54].

Regarding trade linkages as well as foreign direct investment, Germany is (alongside with Italy, Austria, the Netherlands and France) one of the main economic partners of the country. More than 80% of the foreign direct investment until 2004, which added up to a total volume of more than 31 billion € in the period between 1990 and 2006 [7] came from member countries of the European Union. 56% of the FDI went into the industry, mainly into the branches of mechanical engineering and electronic industry [8].

Romania has moved to one of the prioritized locations for German direct investments in the last few years. In July 2007, German companies had invested directly into 15.000 firms in Romania [9]. The German volume was with 1.5 billion in 2005 comparatively low but increased by around 0.9 billion in 2006 [7, 10]. The favourite branches of the German investors are amongst others electrical and mechanical engineering. Important reasons for the preference of Romania as investment location are the low labour costs for a comparatively high educated workforce [11].

This reason has been identified by the Fraunhofer Institute for Systems and Innovation Research as main reason for foreign direct investment in the new member countries of the European Union as well. A study of the institute focused on the strategies of German industrial firms from 2004 to 2006 regarding foreign direct investments and relocation of production facilities abroad. One topic of the survey was the analysis of investment reasons: For 96% of the German direct investments the main reason to invest in the new member countries of the European Union existed in the low costs of labour. The second most important argument, which was relevant for only 18% of the German firms, is the opening of new markets [2]. Another survey arrives at the conclusion that around 67% of the industrial firms from Germany, which shifted production abroad from 2001 to 2006, did this to produce their core products at the new sites [1].

The figures presented in this chapter have the purpose to illustrate the integration but also dependence of the new member countries on trade and foreign direct investment relations with the highly industrialized countries of the European Union. A close-down of foreign invested production facilities – caused by more efficient production strategies in the countries of origin – could hit locations or even regions in the countries quite hard and slow down the development processes. The development path of Romania is a good example to prove this statement: from 1994 until 2002 the foreign direct investments have contributed decisively to the positive annual growth rate of the country. Without the involvement of foreign firms, respectively the anchoring of international production networks in the country, the growth would have been below zero in the considered period [12].

3. GLOBAL PRODUCTION NETWORKS AND NATIONAL INNOVATION SYSTEMS

3.1 The creation of value

The framework of 'global production networks' (GPN) was set up to analyze the organization of production networks operating on a transnational scale and their impacts on the economic development of regions in which they become anchored. The concept delineates regional economic growth as the outcome of the alliance between endogenous growth factors and lead firms spearheading global production networks. Global lead firms, '[...] powerful firms that orchestrate and coordinate complex GPNs in their respective industries that span different territories and regions' [13: 9] integrate the regions through a coupling process to make the regional advantages interact with the strategic needs of GPN firms [13, 14, 15, 16].

The advantage for regions result from the processes, that 'value' as various forms of economic rent can be created, enhanced or captured. 'Value' is regarded as an above-average profit margin which originates for example from the use of specific technologies, improved forms of work organization or synergy effects which result from the co-operation with GPN-firms. Value creation, enhancement or capture happens through market as well as non-market transactions: through the access to particular product or process technologies a

technological rent can be obtained. The improvement of know-how transfer and collective learning in turn generates a relational rent [16].

The coupling process takes place through various forms of interactions of foreign firms with local actors: direct employment, strategic alliances with local firms, linkages to suppliers and service providers, memberships in business associations etc. The integration of a foreign firm into local structures and processes can be measured by several types of embeddedness [17]. Foreign actors achieve territorial embeddedness when they '[...] build considerable links to actors present within the respective host localities' [17: 181, see also 18]. Social or cultural embeddedness exists, when actors share the same 'genetic code' or societal background. 'If actors engage in global production networks, they carry the genetic code with them when going abroad and, at the same time, are exposed to the different cultures of their foreign network partners' [17: 180]. Network embeddedness describes the integration of an actor into social networks.

Value, as defined by the literature on GPN, can be created by an intensive integration of a GPN-firm into local processes and structures. This happens automatically once the regional assets – for example the technological capabilities of local suppliers or the know-how of the local workforce – are from a strategic viewpoint attractive to foreign firms. In case it is only the market which presents an attractive asset of the respective region or nation the coupling process can be enforced by the state – an 'obligated embeddedness' takes place [19]. This happened in the case of German automobile suppliers in China. On the one hand they were obliged to increase their local content through the co-operation with local suppliers. On the other hand they often had to form joint ventures with local firms. Both measures had the goal to increase the technology and management transfer to the local industry. The German firms bypassed the local content regulations as they replaced the majority of Chinese suppliers by-and-by with German or other foreign firms. The differences regarding the technological and organizational interfaces proved to be too large for collaboration [20].

3.2 The meaning of institutional and technological differences for coupling processes

But not only the linkages on firm level are difficult to maintain between firms from different countries. Intercultural relationships on an individual level are just as catchy. Firms that are establishing production capacities in foreign countries also have to bridge cultural, institutional and technological differences on the micro-level, establish efficient communication processes between agents of various cultural backgrounds, and adjust organizational practices that originate in the home country to the context of the host country [21]. Without doing this the delegated management personnel (or the responsible staff at the headquarters) will not be able to overcome existing structures of power relationships, organizational rules and norms of interaction through the creation of new ones. And it will most probably fail to establish an appropriate work organization for a mass customization strategy. Thus, foreign managers have to become '[...] able to convince others about their plans and to mobilize the resources of others' [22: 95]. Power is not a resource one possesses but '[...] a relational practice of the capacity to influence' [23]. This can only happen if expatriate staff can bridge existing cultural differences and gain a social and network embeddedness [17, 19].

Firms that develop activities abroad are directly confronted with the situation that production technologies, quality management guidelines and work organisation principles differ internationally as these are linked to the specific development paths of national systems [24, 25]. According to the concept of national innovation systems, differences will by no means vanish in the future, but instead be reproduced through the permanent actions and interactions of individual and collective actors within their respective systems. Intended or unintended, they change and develop in an incremental way the economic structure and the interrelated institutional framework of the national economy [26].

This favours the development of innovation processes along specific development paths. Technological and industrial specialisations as well as the institutional profile of the national

state again influence on the role of actors and the relationships among themselves. The actors in a system – i.e. entrepreneurs and their employees, researchers, politicians, civil servants, members of economic organisations, etc. – are linked together in specific ways. Institutions guide them in their interactions and determine how knowledge is created.

National innovation systems can be regarded as social systems that reproduce themselves through self-referentiality in interactions. Their basic structure is different from the one of their environment. Institutions, ‘... the things, that pattern behaviour, e.g., routines, norms, shared expectations, morals, etc.’ [27: 43] hold the system together as they assign roles and specific tasks to actors and facilitate interaction and relationships between them [28, 29]. They reduce uncertainty in interactions and are part of a social group’s fund of knowledge. Without them, the group would lack cohesion or disorder could take over [30, 31]. An important differentiation can be made between institutions of formal or informal nature. Informal institutions include non-formalised habits, traditions, norms, conventions and routines that are recognised by the members of a social group. In contrast, formal institutions are stabilized forms of social relations based on laws, regulations and other codified forms of permanent rules that lay down valid behavioural guidelines.

Institutions are manifest at the level of individual actors in habits, which, in turn, are formed from repeated thoughts and actions, and are consolidated in the long term. They become rooted in mental schemes [26, 32, 33]. In addition to institutions, behaviour and the habits of individuals are also shaped by technical preconditions, artefacts and procedures. They guide actors to adhere to specific routines. Concerning the employees in industrial firms, Gertler [34] refers to a “manufacturing culture” that is manifest in different technical standards and training at a national level and that reproduces itself. This suggests that specific machines and production processes can develop in national contexts based on characteristic routines of the actors involved.

In the case of foreign direct investments, national manufacturing cultures cause industrial practices to be exported by expatriate actors to the target regions. Accordingly, encounters with local actors who are embedded in different institutional frameworks and economic structures require the adaptation of rules between the companies in order to make the shared organisation of production possible [35]. National innovation systems thereby hinder a regular distribution of economic practices. Bringing actors and institutions from different economic, societal, and cultural contexts together is thus a difficult task, which is reflected by the numerous failures of multinational mergers and acquisitions in the past.

3.3 Low labour costs and GPN

The conditions in Romania, in Serbia or in Hungary are different from those in China. But in each of these countries a specific manufacturing culture has evolved which expresses itself, for example, in a more or less adherence of employees to informal rules or hierarchies. Even between neighbour countries like Austria and Hungary managers have detected tremendous cultural differences which inhibit intercultural projects [36]. Thus, irrespective of the considered home and host nation, technological as well as institutional international differences, which exist because the national level remains an important factor for the path dependent development of institutions as well as technologies, can strongly inhibit the coupling potential on the micro-level and that of firms [24, 28, 37].

It seems that one central asset of the countries of Eastern Europe has been and still is the low cost of labour. But, as the survey of the Fraunhofer Institute for Systems and Innovation Research suggests, this is not any more enough for a sustainable regional engagement of foreign companies [2]. The major reasons for firms to close down the production facilities abroad are quality and flexibility issues. It appears that institutional and technological differences, which the investing firms did not manage to bridge, have nullified or even outweighed the advantages of low labour costs. One conclusion of this process is that regions have to offer other assets besides cost advantages that make it worthwhile for global production networks to anchor there and to stay anchored.

4. THE MEANING OF SPATIAL AND CULTURAL PROXIMITY FOR MASS CUSTOMIZATION IN THE CAPITAL GOODS INDUSTRY

The implementation of a mass customization strategy requires a shift of the internal organization of a firm irrespective of whether the firm operated in the past as a mass producer or produced tailor-made individual solutions. Every staff member of the future mass customizer – not only the staff responsible for production and assembly – must understand the principles of mass customization and his role in the customer-oriented production system. In comparison to a system of mass production a much higher flow of information has to be processed and shared between the relevant function units. The implementation of a mass customization strategy thus requests – apart from new production equipment and the integration of information technologies – the definition of a new work organisation with different roles and routines compared to the old system.

Furthermore it requests intense face-to-face relationships and communication patterns in the firm as well as between the firm, its suppliers and customers. In the consumer goods industry this doesn't seem to be a prerequisite for the organisation of value creation. The goods are not as complex regarding the functions they have to fulfil as well as their architecture. In addition they also serve the actor who is co-creating them. This is different for capital goods. Typically, the one who is responsible for the configuration and acquisition does not have to operate them. To make sure the equipment fulfils its duties and fits into the production process he has to communicate intensively with the staff in charge of production or has to be well experienced. Therefore it is assumed that the configuration process is not, as for example in the 'experience-shopping' process of ordering a new pair of mass customized shoes [5], an emotional experience for the buyer. He doesn't satisfy a long standing personal desire with the product. Instead he has to make sure that the product fits in a predetermined production system.

From the viewpoint of the buyer it seems to be absolutely necessary to have a contact person at the vending firm to whom he can get back in case the equipment is not functioning as intended or it has to be adapted to additional needs. And this contact person has to arrange the problem solution with the respective functional units within the firm. Thus, the interpersonal linkages in-house as well as between the buying and the selling firm seem to play a crucial role in a strategy of mass customization in the capital goods industry. IT-based configuration systems in the capital goods industry can support the co-creation process. But they can not substitute face-to-face contacts. Hence, the challenges for a capital goods producer at the implementation and operation of a mass customization strategy differ to those of a consumer goods producer.

In the implementation stage it also seems that the dependence on external capabilities is higher than the one in the consumer goods business.

- Products have to be modularized and a stable solution space established [6]. The redesign of the products implements a close collaboration with capable suppliers and might also imply the assistance of specialized engineering services. A close-by location of the firms enables a flexible and quick organisation of meetings and face-to-face interactions whenever these are required.
- Simultaneous to the products the organisation of the production has to be changed [4, 5]. In many cases mass customizers organize the production and assembly of their products in teams and shift from a line production to one based on production cells. At the design stage of the new work organisation the respective firm might choose to cooperate with business consulting firms. The training of the workforce might also be carried out or supported by external service providers.
- Furthermore, firms have to invest in the development of an IT-supported configuration system. This again might make the close cooperation with IT-service providers necessary. The software for the configuration processes has to be linked to the other IT-supported systems of the firm as, for example, the one for enterprise resource planning, for production planning and control, for the customer relationship management and so on [4].

- Furthermore, a mass customization strategy might imply the acquisition of flexible machines which enable the processing of more than one part or product. It might also be that the new machines require more effort for service and maintenance. In both cases, bought in IT-services and equipment maintenance, a spatial proximity between service providers and customer supports quick problem solutions.
- In addition, the service providers have to deal with very specific solutions for the mass customizer. Thus they need a sound knowledge of the structures and processes established in the mass customizing firm. This 'shared knowledge' provides the basis for trustful relationships and efficient problem solutions [38]. Trustful relationships do not only rest upon technical capabilities. They also have an institutional dimension. 'Trust can be defined as the judgement one makes on the basis of one's past interactions with others that they will seek to act in ways that favour one's interests, rather than harm them, in circumstances that remain to be defined' [39: 305]. If informal and formal institutions foster trust, future cooperation and projects have a much higher success rate.

A further task in the implementation stage of mass customization is the restructuration of the internal organization of the firm. This does not only require an intensive training programme for the staff. Furthermore, communication structures have to be adapted to reach an efficient integration of all the units. To achieve this, existing routines need to be changed and new ones need to be established. Workers have to be assured that they are not going to be disadvantaged as a result of the restructuration process. Without knowing and considering existing informal institutions among the workforce the management, which creates the new work organisation, risks the establishment of a system that will not be accepted and adapted by the employees. Without knowing the underlying social rules of action and interaction a management will hardly be in the position to get the workers where it wants them to be. Cultural distance can result in a decoupling of the management from its workforce [20].

The implementation of a mass customization strategy in a firm of the capital goods industry thus is eased through a cultural proximity between the management and the workforce and a spatial, institutional and technical proximity between the firm, its suppliers and service providers [40]. At the operating stage this also applies for the linkages to the customers. Now it is the mass customizer who needs to know about the requirements of his customers to translate them into products and services. It has been already pointed out that a virtual proximity – a relationship based solely on the interaction through an IT-configuration system – does not work in the capital goods industry. To serve his customers, a mass customizer needs capable and flexible suppliers located close-by to make sure that high quality products are delivered in an appropriate time [41].

All the listed arguments favour the localization of a mass customizer in a cluster: a local or regional concentration of industrial firms that are closely interrelated through traded and untraded interdependencies and their support infrastructure. Clusters can be analyzed along several dimensions – horizontal, vertical, institutional, external, and power [21, 22, 42].

Especially important for an implementation of a mass customization strategy appears to be the vertical dimension of a cluster, which consists of firms with complementary products and competencies that are linked through supplier and customer relations. These firms benefit from intensive transactions within the cluster and form networks of traded interdependencies. An existing agglomeration of specialized producers creates an incentive for specialized suppliers and service firms to move close to these customers. The firms, in return, benefit from low transportation and transactions costs, as well as economies of scale, and thus gain a competitive advantage [43]. In part, these cost savings explain why existing clusters tend to grow, giving rise to labour market specialization.²

But the advantages of clustering cannot be grasped by the concepts of cost and traded interdependencies alone. In emphasizing localized capabilities [44, 45] and untraded interdependencies – resulting from a common coded language, norms, customs and practices, which lead to easier communication and facilitate trust and cooperation [22, 46, 47] – recent studies have provided evidence that clusters offer manifold opportunities for interfirm communication and interactive learning within the same socio-institutional and technological environment [24, 48, 49] that generate specialized flows of information and support innovation [38, 42].

In general, the successful establishment of communication in a particular production configuration requires the development of a shared institutional context that enables interaction and the creation of knowledge. Conventions, accepted rules, norms, common standards, habits, shared heuristics, attitudes toward technology, and other institutional arrangements are also of great importance to enabling interfirm communication and collaboration in the context of a cluster [42, 46]. A joint institutional framework – the institutional dimension of a cluster – enables specialized users and producers to discuss and solve problems [50, 51]. Such a framework does not, however, exist spontaneously. Through interactions among the actors of a cluster, joint problem solving and experimentation lead to preliminary solutions, which must be robust to survive the next series of interactions. These solutions are constantly updated or adjusted to fulfil new goals in the innovation process [47, 30] and thus become more specific over time. The role of institutions becomes even more complex in a multinational production setting, where different rules of conduct exist that are not easy to grasp [28, 25].

5. CONCLUSION

Mass customization is regarded as a strategy for firms to move closer to the customer. It combines elements of mass production and individualization, can reduce the costs of a firm and increase its productivity. It is estimated that mass customization products have a potential to reach a market share of around 30% [5]. This should also be under consideration when reading the arguments of this paper: an implementation of mass customization will take place only in specific branches and, thus, will only have a limited impact on the distribution of foreign direct investments.

The implementation of mass customization requires from industrial firms a reorganisation of their internal structures and processes and additionally a more intensive collaboration with suppliers and customers. As an implementation of mass customization depends on efficient

² Two other dimensions might also favour a location of a mass customizer in a cluster: The horizontal dimension offers advantages for firms as the collocation provides the opportunity to watch other firms closely and compare the own economic performance with that of others [46], because firms in a cluster basically operate under the same conditions and share the same labour market, set of local suppliers, and cost structure [21, 42]. Furthermore, power asymmetries between the actors of a cluster generate the potential for efficient problem-solving. They help to settle conflicts and to speed up decision making processes [22, 42]. Given a multinational production context, decision making and problem solving processes might be impeded as actors are embedded in different hierarchical structures and power relations [20, 21].

intrafirm communication processes and the willingness to learn of the workforce as well as a close collaboration with suppliers, service providers and customers, a cultural proximity between the involved parties smoothens the process of change. In the implementation stage as well as in the operational stage a mass customization strategy is further facilitated through the embeddedness of a firm in local or regional cluster structures.

Therefore, it is argued, an intensified implementation of mass customization in capital goods industries in highly industrialized countries in Western Europe could entail relocations of production facilities from foreign direct investments made in East European countries back to the countries of origin.

What lessons might be drawn from this analysis? Individual local firms in Eastern Europe can, of course, try to find strategic partners or customers in Western countries. But their individual efforts won't hardly be enough to contribute to a noticeable value creation, enhancement or capture within a region, unless it is a very big firm like the former state owned enterprise Dacia in Romania, which operates successfully since it became a subsidiary company of Renault. Still the question persists how much of the value created through the collaboration remains in the region of Pitesti and how much is transferred to Renault.

To gain access to global production networks, local firms will also have to adapt to specific standards which exist in the respective industrial branch or global production network [52]. Furthermore they should also know about the cultural norms of their respective partner firms [25].

But as mass customization is a production strategy which benefits from cluster structures it seems to be a promising strategy for regional authorities to foster the development of clusters to foster the regional assets and to increase the attractiveness for foreign direct investment. In the countries of Eastern Europe clusters can not be decreed and planned by policymakers – as this happened by and large for example in the case of the automobile industry in Shanghai [21] – but their creation and development can be supported by taking measures, for example, to strengthen regional networks in interrelated industries or to create and enhance stable and deliberative institutional conditions. But cluster initiatives should not start from scratch. Policymakers should know about the local and regional assets and how they relate to various global production networks. Intervention should be designed to strengthen the assets and to develop them towards regional cluster structures.

If regions succeed to strengthen their localized capabilities and become precursors in specific fields, they automatically become attractive for foreign firms as a kind of knowledge pool. In that case the foreign firms for sure evaluate the problem of cultural differences as one they are willing to solve.

This article indicates the need in the research on mass customization to integrate the relevance of spatial aspects into the considerations about interfirm networks and linkages in mass customization arrangements but also the dependence of the internal organisation of production from localized capabilities. The arguments in this paper draw mainly on theoretical considerations and can offer the conceptual framework for an empirical validation. This seems to be a desirable and necessary amendment of the existing knowledge as the spatial organisation of mass customization arrangements have been neglected and under-conceptualized in the literature on this topic.

An interesting extension, to be considered in the future, would consist of examining the performance of WIP controller when applied to reentrant systems, in which parts may visit some machines more than once. More complex patterns of demand should be considered.

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