

Production Next Door – A business model for local, sustainable production

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Abstract – In many industries today, the manufacture of products is characterized by global value creation processes based on the division of labour. However, various crises (e.g. global pandemic, trade conflicts, global warming) show us the limits of global production. The risks and emissions of complex, global supply chains, inadequate labour and environmental standards along the value chains or customs barriers are leading to a rethinking in different sectors. Local production offers an opportunity to overcome current and future challenges by reducing cycles of value creation and involving regional actors. Local manufacturing can especially contribute to social, ecological and economic sustainability if it takes three dimensions into account (LM³): production at the place of need, production on site and production using local resources.

The project "Digital Urban Production" is dedicated to the question of how local production can succeed. At the same time, it tries to develop a business model based on these findings and to implement it in the field of furniture manufacturing for Hamburg with the concept "Production Next Door" (ProNeD). This paper shows how ProNeD's business model aims to promote the path to local production as understood by LM³.

Keywords – Local Production, sustainable production, business model, production network, Value Creation

NOMENCLATURE

BM	Business Model
SME	Small and medium sized enterprises
ProNeD	Production Next Door

I. INTRODUCTION

Industrial product manufacture today is realized by global value creation processes based on the division of labour. There is no doubt that this form of value creation using local specialization and regional competitive advantages (e.g. lower labour costs) enables cost-efficient production and reliable product availability in many areas. The world is currently facing many ecological, social and economic challenges, with global manufacturing often amplifying them: disrupted global supply chains due to a pandemic or increasing international crises, international trade conflicts, structural impoverishment of regions, insufficient harmonization of labour and environmental protection standards along global value chains.

In many scenarios, the return of product manufacture to the place of demand offers potential for countering the negative effects of global value creation based on the division of labour. The emergence of local markets and the promotion of local production represent a central dimension of the transformation to a circular economy [1]. Local production needs to ensure that regional producers are able to produce a wide range of products to satisfy specific regional demands [2, 3].

Local production can take various forms. In many areas regional clusters exist, which bundle competencies through local value chains and the companies as a whole form a competitive consortium in global markets (e.g. Hamburg Aviation, Life Science Nord). Likewise, global corporations promote forms of local production by performing the final steps of the value chain close to the customer (e.g. regional product manufacture by Coca Cola). Trades and crafts also represent a form of local production, which individually addresses the needs of customers on site in smaller batches.

The different forms of local production can be described based on the following three dimensions [2]:

- (1) **Production at the place of need**
- (2) **Utilization of local resources** by implementation of production by local stakeholders and using local (raw) materials
- (3) **Addressing of local demands** by producing individualized / locally adapted products on-demand

The gradual implementation of these three design dimensions of local production offers great opportunities for ecologically, socially and economically sustainable value creation in various sectors. **Ecological sustainability** is achieved by reducing value creation cycles, so that the extensive transport of products and resources can be avoided [4]. In addition, the spatial agglomeration of producers and customers simplifies the return of used products to regional material cycles [5]. Furthermore, local on-demand production reduces overproduction and storage costs for semi-finished and finished products [6]. **Social sustainability** is promoted by involving a large variety of regional actors to secure and create local jobs and increase the quality of life on-site. Furthermore, the local value chains facilitate equivalent working standards. Local production moreover promotes regional structures for value creation (investments in local infrastructure, local qualification of skilled workers), which promotes **economic sustainability**. In addition, the spatial proximity between producer and customer simplifies the fulfilment of region-specific requirements and the forecasting of changes in consumer behaviour [7].

II. MOTIVATION

Many examples from different sectors of the economy partially fulfil the stated dimensions of local production (e.g. regional clusters bundle the competencies and resources of local producers, but the products are made for a global market). Patterns of local value creation, which are characterized by (1) **on-site production** with the (2) **involvement of local stakeholders and regional raw materials and materials** to (3) **meet regional needs**, only represent a small portion of value creation in the manufacturing sector. Since the three dimensions of local manufacturing (LM³) are often not met at the same time, the full potential of local production cannot unfold.

The research project "Digital Urban Production" funded by dtec.bw (Digitalization and Technology Research Center of the Bundeswehr) starts here and contributes to the targeted promotion of local value creation patterns. For this purpose, the project expands the understanding of the systematics of local value creation and develops principles for the design of local value creation systems and the development of corresponding business models. But not only the understanding, also the actual implementation is part of the project, i.e., the research results will be applied to a business model that is to be tested in the real-world.

The results of the study analysing the systematics of local production are presented in section III. The main influencing factors of local production are listed and assigned to the social subsystems that significantly influence them. Subsequently a concept for a local manufacturing network is presented for the sustainable production of customizable furniture in the Hamburg area (refer to section IV). Finally, concrete measures for designing the local production network are presented, which address the dimensions and key factors of local production (refer to section V).

III. STUDY ON THE SYSTEMATICS OF LOCAL PRODUCTION

There are many scientific approaches that deal with the systematics of local production, but focus on different aspects (refer to TABLE 1).

TABLE 1: DIFFERENTIATION OF THE RESEARCH FOCUS OF DIFFERENT SCIENTIFIC APPROACHES TO THE TOPIC OF LOCAL PRODUCTION.

Scientific approach	Research focus
Re-Distributed Manufacturing	regional circular economy
Urban Manufacturing	production in the city
Distributed Manufacturing	decentralized value creation

The variety of perspectives supports a comprehensive understanding of the research object. Due to the focus of the research, there is a risk that the relevance of influencing factors on local production will be over- or underestimated depending on the considered concept. As part of the dtec.bw project "Digital Urban Production" a study was performed, which aims to expand the general understanding of the systematics of local value creation combining the different research foci of the concepts mentioned.

For this purpose, the key factors and their relevance to the emergence of local value creation patterns were identified using an adapted sensitivity analysis according to Vester [8].

The analysis is based on a meta-review of publications on the different concepts. Knowing these key factors supports a targeted design and promotion of local value creation patterns.

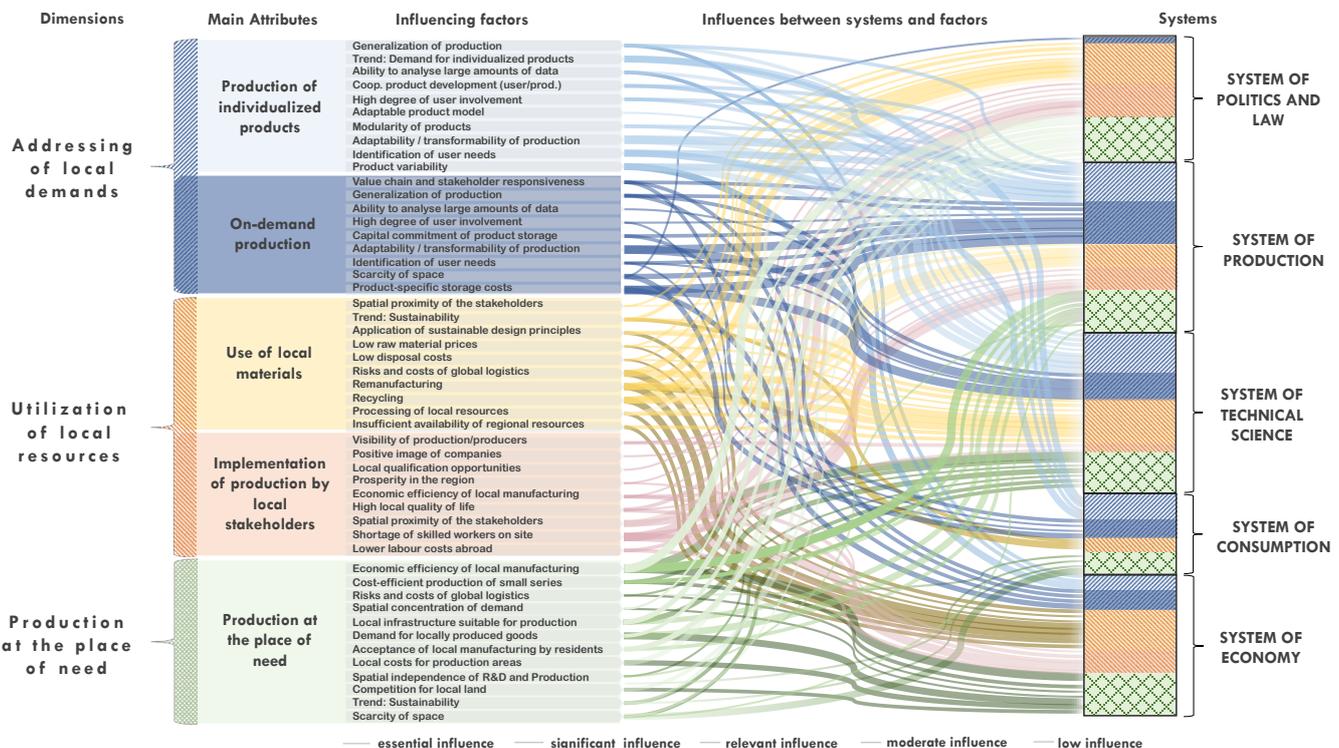


FIGURE 1: ASSIGNMENT OF THE KEY FACTORS OF LOCAL PRODUCTION TO THE SPHERES OF INFLUENCE OF SOCIETAL SUB-SYSTEMS.

In a second step of the study an analysis was carried out to assign the identified key factors to areas of influence of different social sub-systems (e.g. politics and law, economy, production, consumption, technical science). This shows how the areas of law and politics, business, production, science and consumption support or limit the emergence of local production.

FIGURE 1 shows the identified influencing factors, their assignment to the dimensions of local production and the areas of influence of the social sub-systems. Future development of local value creation patterns is not just based on technological innovations from science or new business models in production. Rather the conditions for local production, which are largely determined by the areas of law and politics or the economic system, need to be adjusted (e.g. availability of skilled workers, local infrastructure).

IV. CONCEPT AND BUSINESS MODEL OF PRODUCTION NEXT DOOR

Knowing the dimensions and the associated influencing factors of local production enables the creation of a targeted design of value creation systems, which aim to produce at the place of demand, using local resources (actors and materials) to satisfy specific, regional needs.

The concept “Production Next Door” (ProNeD) was developed as part of the dtec.bw project “Digital Urban Production”. ProNeD creates a **platform-based production**, which combines the potentials of global product development and manufacturing on-site. Besides this it provides the customer with easy access to **locally produced goods**, allows them to **individualize** them and ensures an **efficient coordination** between all participating stakeholders along the product development process.

The development of products is done by including global, open communities using the wisdom of the crowds [9]. These ideas are then provided with a free license (open source hardware), so that they can be manufactured wherever they are needed. This enables the establishment of regional value creation networks, which manufacture and distribute these products locally. The customer can buy them in a webshop and also adapt them to his/her individual requirements (customizing).

The different steps of the value creation process (development, manufacturing, sales) are digitized and supported by a virtual platform to integrate the activities of the different groups of actors (developers, producers, customers). The goal of digitization is to enable an efficient integration of production-ready designs through global communities, order-controlled, automated planning of dynamic, regional value chains and user-friendly product customization for the customer.

A. ProNeD’s goals

The main objective of ProNeD is to establish a form of local, demand-driven production to promote ecologically, socially and economically sustainable value creation.

ProNeD enables on-site production for the customer for a product segment that was usually implemented by centralized, industrial production beyond the region. By reducing value creation cycles, transport routes are reduced and **ecological sustainability** is promoted. The spatial agglomeration of producers and customers also simplifies the return of used products to regional value creation cycles (e.g. repair, remanufacture). The production is based on the principle of “on demand”, and therefore helps to reduce overproduction as well as costs and emissions for storage of semi-finished and finished products. ProNeD contributes to **social sustainability** by involving a high diversity of regional actors to secure and create local jobs. **Economic sustainability** is achieved by promoting local value creation structures (investment in local infrastructure, local qualification of skilled workers). However, the costs of locally produced goods are often significantly higher than those of industrial production based on the division of labour (e.g. because of economies of scale). To counter this, ProNeD aims at a continuous digitalization of cross-company product manufacturing to improve costs compared to the currently common individual commissioning (e.g. by reducing initiation and coordination costs). Development costs are reduced through the implementation of global communities and the use of open product licenses, which enable the product to be manufactured in a variety of local value creation networks. Furthermore, the benefit of the service for the customer is extended by product individualization.

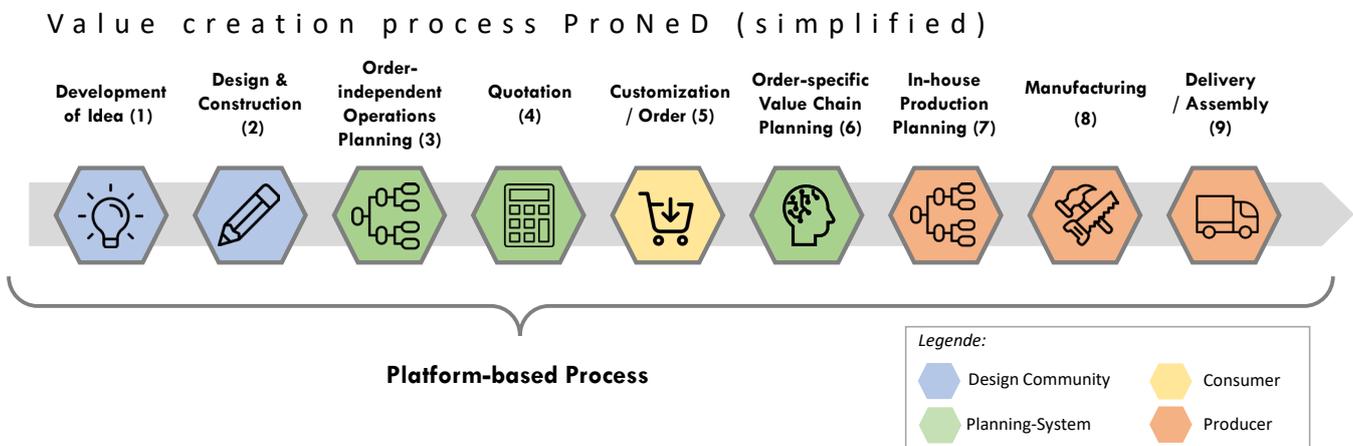


FIGURE 2: PRONeD VALUE CREATION PROCESS.

B. ProNeD's process

ProNeD establishes a manufacturing platform that supports the product development process from the initial idea to the delivery of the product (see FIGURE 2). The platform therefore integrates the activities of global communities for development, the planning of local value chains and the customization by customers. With this ProNeD aims to reduce transaction costs between the large number of players involved as well as to align the product development with the capacities of local production on-site.

The process starts when a customer or developer publishes an idea on the platform (1). A community vote is used to select the most promising ideas fitting best to the concept of ProNeD (e.g. producibility in the local network, sustainability criteria, expected production costs, design). During the phase of design and construction (2), a team of developers converts the idea of the product into a digital product model, which can be produced directly by the local network. To support the developers with the construction of a finalized product model producers participate in the team for development. A product maintainer supervises the distributed development process. The platform guides the team through a standardized development process in virtual development spaces [10]. Based on the finished product model the technical system performs order-independent automated operations planning (3) to identify potential local value chains for manufacturing. In addition, the identified value chains are evaluated according to predefined criteria chosen by the customer (e.g., cost, time, environmental sustainability). The creation of the sales offer is automatically prepared by ProNeD's sales system (4) based on the product model and finalized by the product maintainer. Finally, the product is offered to the customer on the sales platform. The customers are able to adapt the product according to their individual needs via customization (5). They can modify its visual and functional properties (e.g. dimensions, materials, colour) and influence the systemic design of the value chain (selection of criteria for determining the producers) according to sustainability criteria (e.g. use of green electricity by the production companies, preference for companies with high social commitment). The purchase of the customer causes the next step: order-specific value chain planning (6). Depending on the wishes of the customer and currently available resources in the production network, the planning system selects the most suitable value chain for manufacturing of the product and awards a contract to the producers involved. The planning system supports the control of the cross-company manufacturing process (7) by continuously communicating the current product status to the stakeholders involved. Once manufacturing is completed, the distribution system manages the interaction between the producers and the customer to coordinate the delivery and assembly (8).

C. Stakeholders and dimensions

Value creation at ProNeD is determined by three groups of stakeholders: Developers, producers, customers.

Developers operate within global, open communities. Depending on their skills and preferences, they take on the role of idea providers, designers and design engineers. Through their participation at ProNeD, developers can implement and commercialize their own product ideas with the support of a community and production network. Depending on their role and contribution during the development process, developers

receive pro-rata compensation for each product sold through the platform to which they have contributed.

The **producers** are regional crafts businesses or small manufacturers. They have different professions and specializations. By combining the diversity of regional manufacturing capacities, it is possible to realize a wide range of potential products. On the one hand, the regional producers expand their business field by being part of the ProNeD network and gain access to new customer segments (see Stoltenberg et al. in this volume). Furthermore, the producers reduce uncertainty (fluctuating prices, risk of not being awarded a contract in the initiation phase) and the effort required to initiate a contract.

The **customers** are local individuals who value regional or individual product manufacturing. By specifying personal preferences, the customers can shape the value chain and learn in detail how their products are made (transparency regarding the value chain). In addition to the social-ecological benefits, customers using ProNeD benefit from opportunities to individualize the product, an efficient initiation and ordering process and the selection of criteria which are considered in the supply chain deployment (economic-functional benefit).

D. Viability of the concept ProNeD

The development and operation of the ProNeD platform must be ensured to receive a viable business model. For this purpose, a pro-rata commission to the platform for each product sold will be implemented. However, each local value network serves only one regional market, which limits the target group in terms of space. Funding of the platform is also secured by the fact that the concept can be transferred to other regions or cities. In the pilot phase, the project will be realized in Hamburg focusing on furniture production.

V. DESIGN OF THE PRONeD MANUFACTURING PLATFORM

The results of the study about the systematics of Local Manufacturing presented in section III show the need for different social sub-systems to work together to promote local forms of value creation. Over the course of the project "Digital Urban Production", we contribute to the promotion of Local Manufacturing mainly through the system of science and the system of production.

In the system science we perform research and development activities which focus on combining global product development with Local Manufacturing activities to improve the flexibility and agility of local value chains. Furthermore, we act in the sphere of the system production by developing a new value creation concept ("Production Next Door") for regional furniture production. Within both systems we address and therefore *directly* influence various factors of local production (e.g. adaptability/transformability of production, cooperative product development). However, we *cannot directly* influence the characteristics of many factors that affect the sphere of the systems politics and law, economy or consumption. To those we can only *react* by choosing the context and the design of the business model.

TABLE 2, TABLE 3 and TABLE 4 list measures, which were developed as part of the project to promote the concept ProNeD within the Hamburg Metropolitan region and to establish new structures for local production. The lists also show which measures directly impact the characteristics of the key factors (active measures) and which merely react to the situational characteristics of key factors (passive measures).

With this we see that most of the active measures of the concept ProNeD affect key influencing factors of the dimension "addressing of local demands". By contrast, the measures listed respond primarily to the characteristics of the influencing factors in the dimensions "production at the place of need" and "utilization of local resources in value creation" by selecting the appropriate context (product segment, branch, location) and designing the business model (e.g. demand for locally produced goods). These measures can be classified as passive.

TABLE 2: "PRODUCTION AT THE PLACE OF NEED" AND ITS INFLUENCING FACTORS OF LOCAL MANUFACTURING AND ASSOCIATED DESIGN MEASURES.

<i>Production at the place of need</i>	
<i>Influencing factors of local production</i>	<i>Associated design measures of the ProNeD concept</i>
Economic efficiency of local manufacturing	Selection of a market segment with a higher price level
Cost-efficient production of small series	Platform-based integration of development, planning and sales to reduce transaction costs along the value chain / Digitization of coordination processes in the local value network
	AI-based decision systems to optimize value chain design and selection
	Production-ready design by global communities to ensure efficient manufacturing by local producers
Local infrastructure suitable for production	Provision of product portfolio through community-based product development to reduce development cost
	Selection of the Hamburg metropolitan region due to suitable infrastructure for the production and delivery of furniture for a regional market (e.g. energy security, availability of service providers in the field of IT or machine technology, logistics service providers)
Demand for locally produced goods	Selection of the Hamburg metropolitan region due to urban, and wealthier target group than the national average
Spatial independence of R&D and Production	Crowd-Engineering-Platform: using crowd engineering platform to involve global developer community in product development for the local production network
Trend: Sustainability	ProNeD's value proposition for the customer based on sustainability
	Customer choice for individual value chain design according to sustainability criteria (social, environmental)

Type of impact: ■ passive ■ active

TABLE 3: "UTILIZATION OF LOCAL RESOURCES" AND ITS INFLUENCING FACTORS OF LOCAL MANUFACTURING AND ASSOCIATED DESIGN MEASURES.

<i>Utilization of local resources</i>	
<i>Influencing factors of local production</i>	<i>Associated design measures of the ProNeD concept</i>
Shortage of skilled workers on site	Selection of the Hamburg metropolitan region due to high availability of skilled workers and training options
Spatial proximity of the stakeholders	Selection of the Hamburg metropolitan region due to high availability and spatial proximity of craft businesses
Positive image of companies	Selection of the woodcrafting industry due to its positive reputation among the population
	Selection of producers with regard to value-based management
Visibility of production/producers	High level of transparency to present the product manufacturing process and the producers involved to the customer
Application of sustainable design principles	Sustainability as a central criterion for the selection of products in the idea phase and the design of the products in the design phase on the crowd engineering platform

Type of impact: ■ passive ■ active

TABLE 4: "ADDRESSING OF LOCAL DEMANDS" AND ITS INFLUENCING FACTORS OF LOCAL MANUFACTURING AND ASSOCIATED DESIGN MEASURES.

<i>Addressing of local demands</i>	
<i>Influencing factors of local production</i>	<i>Associated design measures of the ProNeD concept</i>
Product-specific storage costs	On-Demand Production: Start of product manufacturing takes place only after the order is placed by the customer
Adaptability / transformability of production	High diversity of players in the regional value creation network
	Participating Stakeholders are generalists
High degree of user involvement / Cooperative product development	Highly flexible composition of local value chains through automated value chain planning
	Open access to product development for customers and developers
Ability to analyze large amounts of data	Transparent presentation of the product development from the first idea to the delivery of the product via the ProNeD platform
	Use of technical analysis systems to evaluate customer requirements and participation of producers in the value creation process

Type of impact: ■ passive ■ active

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As an actor operating in the production and science system, we can thus serve the dimension “addressing of local demands” well. However, for Local Manufacturing in the sense of LM³ to work, the other dimensions of local production must also be addressed. For this, however, it is necessary to operate in the other sub-systems. Further efforts to promote local production must therefore increasingly address the scope of the systems politics and law, economy and consumption.

VI. CONCLUSION

As global value creation, based on the division of labour, often causes various ecological, social and economic challenges, local production has the chance to counteract these negative effects. Thus, it has the potential to establish a more viable form of production, as it promotes ecological, social and economic sustainability.

For this potential to be realized, the three dimensions of local production must be considered (production at the place of need, utilization of local resources, addressing of local demands). The concept of ProNeD aims to address these three dimensions within its business model, that is based on establishing a platform-controlled value creation process for furniture production in Hamburg. The integration of a supraregional or global community for product development supports the creation of new designs, opportunity to participate in a value creation process for various actors as well as cost advantages. Since the platform controls the operations, coordination costs can be reduced. Manufacturing by local players enables individualization potentials that reach beyond those of industrial production. The involvement of the crafts can better serve the individual needs of consumers, which leads to more tailored products. These, in turn, give rise to hopes of a longer product life. ProNeD therefore promotes environmental sustainability by relying on local production on-site and thus not requiring long supply chains. Due to the manufacturing by local producers it also promotes social sustainability by supporting those, thus securing jobs and skills in the region. With ProNeD, customers can customize their products according to their needs and also influence the configuration of the value chain.

ProNeD can thus serve the three dimensions of local production and also the three dimensions of sustainability. However, as ProNeD is a concept of the project “Digital Urban Production”, it acts as part of the system production and science. In other parts, it has to adapt to existing circumstances and conditions. In order to ensure the success of this form of local production, efforts in those other parts of the society are necessary (e.g. promotion of the local infrastructure, training opportunities, etc.).

If all sub-sectors create the conditions for local production (in the sense of LM³), each within its own framework, and thus ultimately work together, the way to more sustainable, stable value creation can succeed.