

Customer-Oriented Sustainability Criteria for Value Chains in Local Production Networks of SMEs

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Abstract – Today’s production sector is shaped by global supply chains and the division of labour. However, in light of recent crises showcasing the vulnerabilities of these global supply chains, a new research interest in local production has been sparked. Local value chains make it possible for the customer to be closer to where their goods are produced, which may increase people’s awareness of manufacturing circumstances. For that reason, the project Production Next Door (ProNeD) introduced the idea for the customer to be able to choose between different sustainability criteria that are used to determine the value chain through which their product will be manufactured. That way the customer is involved in the entire value creation process and may participate more actively in sustainable choices. This paper addresses the challenge of forming criteria that are relevant and meaningful to the customer but also applicable to small and medium-sized Enterprises (SME), as well as founded in standards and thus measurable. To this end, a consumer survey as well as literature on sustainability reporting is analysed to systematise key indicators for assessing sustainability within a company that meet the requirements of the European Union and its directives. This general approach is intended to also familiarise small and medium-sized enterprises (SME) with the upcoming European sustainability directives.

Keywords – *Local production, sustainability, small and medium-sized enterprises*

NOMENKLATUR

SME	Small and Medium-Sized Enterprises
ProNeD	Production Next Door
VCP	Value Chain Parameter
KPI	Key Performance Indicators

I. INTRODUCTION

Sustainability has been one of the most widely discussed topics of the last few years. With the manufacturing industry being one of the contributors of climate change with the use of resources, cause of emissions and transport of materials, just to name a few, sustainability has been quite prevalent in manufacturing research. One approach recently discussed to become more sustainable is to produce more locally to avoid long transport and to enable smaller value creation circles. This would encourage, e.g. repairing products to extend their usage. Local production close to the customer, however, may

also empower consumers by including and involving them in the value creation process.

There are various ways with different depths of involvement, in which this can be and sometimes already is done. In FabLabs or shared workshops, e.g. the consumer may actually also act as the producer [1], [2], becoming part of the value creation process. In this paper, the focus will be on ways that allow a moderate level of customer involvement in the value creation process of products that they order from a production network of micro and small enterprises (MSE). The type of network this will be targeting, and the corresponding process steps are detailed in a previous publication [3], will be briefly described in Section II.

The idea is to empower the customer by giving them the possibility to choose the underlying principles of the value chain. These could be economic principles, such as finding the cheapest or fastest value chain. Considering the growing awareness for sustainability, however, principles such as finding the value chain with the shortest transport distance could also be relevant to the customer.

This begs the question of which principles or value chain parameters (VCP) are measurable with reasonable effort and are important and relevant to the customer. To answer this, multiple sources were used to identify potential value chain criteria or parameters. First, a customer survey was conducted within the project to find criteria important to customers. Then, existing norms and standards on sustainability in SMEs were analysed to find the ones that could be used to measure the previously found criteria.

This paper is structured as follows. Firstly, background information regarding the network application Production Next Door (ProNeD) is presented. Next, we describe the methodology and approach as well as the sources for identifying potentially relevant VCPs. In Section IV these VCPs and their rating in a consumer survey are described. Section V classifies and details the VCPs chosen for implementation. Section VI introduces applicable standards and norms for sustainability criteria in SMEs and, thus, assigns trackable and measurable KPIs to the VCPs. Lastly, a brief summary and outlook will follow.

II. USE CASE: LOCAL NETWORK PRONeD

This paper will focus on criteria fitting the use case ProNeD, or Production Next Door. ProNeD is a digital plat-

form solution designed for the demand-driven local production of goods. The concept and development are part of the Digital Urban Production research project at Helmut Schmidt University/University of the Federal Armed Forces in Hamburg. The platform is currently in the development phase, with operations scheduled to begin in 2024. Initially, the focus will be on furniture production. To this end, a production network in the furniture industry has been established in the Hamburg metropolitan area. The platform integrates advanced planning technology, which automatically contacts the partners in the value network who are best suited to fulfil a value-adding task. The value chain is reassembled for each order, dynamically responding to current demand and the capacities of the producers. Additionally, during the product development phase, global developer communities are involved through the platform.

ProNeD has the goal of benefiting both, the producers and the customers. The platform will use existing producer capabilities but bring them together more effectively through a planning tool developed specifically for easy use with low initial investment. Furthermore, the cooperation with other companies is meant to build a community and increase visibility with local potential customers. Further potential benefits of this type of collaboration are detailed in [4].

Customers can comfortably purchase high-quality, sustainable, customised products via an online platform. They also receive information on where and by whom their piece of furniture was produced. Besides the option to customise size, colour and material, they are also offered the option of choosing between different VCPs. This is meant to empower consumers to actively influence the principles with which the producers for their order are chosen.

III. METHODOLOGY AND APPROACH

First, potential customer-relevant VCPs were brainstormed by a group of experts. These parameters were then presented to participants of a digital consumer survey. The survey contained 20 questions in total and was executed by a market research company with 300 consumers residing in Germany [5]. Through screening questions, it was ensured that the participants had bought furniture within the last three years, would consider purchasing furniture online or from a carpentry and had a household net income of €3,000 or more per month [5]. Using the results of the survey, as well as insights gained from interviewing potential producers, a few parameters were chosen to be offered to customers in the ordering process. To use the parameters, however, they need to be quantified so that value chains can be rated according to them. Therefore, 43 existing norms and standards on sustainability in SMEs were analysed according to KPIs and measurement variables.

IV. VALUE CHAIN PARAMETERS

Relevant and suitable parameters for the ProNeD use case must be defined to offer customers a choice of VCPs. This was done in three steps. First, possible parameters were found, then rated by customers, and then modified to fit the platform requirements. This should ensure that customer opinions, which are important for success, are taken into account at the earliest possible stage, thus enabling prioritisation during the platform design phase.

A. Parameter Identification and Consumer Rating

As a first step, parameters that might potentially be relevant for consumers were brainstormed in a multidisciplinary workshop. Seven criteria were selected for further investigation. These criteria were presented to participants of the aforementioned consumer survey with a general description of the ProNeD scenario. The participants were asked to rank potential VCPs according to importance: “Imagine you could choose between different manufacturing criteria in the above scenario. Which of these would be of most interest to you? Sort the possible answers according to how important they would be to you personally. To do this, click on the fields in the order in which you would like to sort them. Start with the most important aspect for you.” Figure 1 shows the relative number of times each suggested parameter was chosen as the most relevant one.

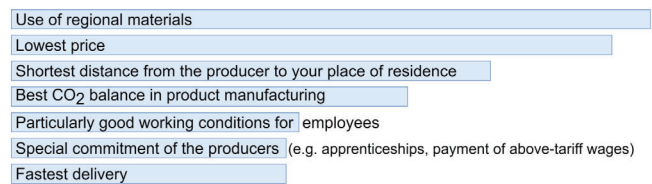


FIGURE 1: MOST RELEVANT VCPs ACCORDING TO THE CUSTOMER SURVEY

Consequently, consumers value the use of regional raw materials and a low price the most. Closeness to the producer and a good CO₂ balance follow with some distance in importance. Some still chose the remaining three factors as the most important, but there is a significant gap compared to the leading criteria. There is, however, no parameter that was generally viewed as unimportant by the survey participants.

B. Discussion of the Identified VCPs

Out of the identified parameters three were chosen to be offered to the customers in the first launch of the ProNeD platform. Some were discarded altogether, while others will be reconsidered at a later, more advanced time. An overview is provided in Table 1.

TABLE 1: OVERVIEW OF THE VCP OPTIONS

Parameter	Included	Discarded	Later
Use of regional materials	x		
Lowest price		x	
Shortest distance from the producer to place of residence			x
Best CO ₂ balance in product manufacturing	x (modified)		
Particularly good working conditions for employees	x		
Special social commitment of the producers	x		
Fastest delivery	x		

The “*use of regional materials*” is not a parameter that is inherent to a producer, but rather a choice producers make when purchasing their raw materials. This parameter will thus be included in the customisation options of materials rather than in the VCP options. The parameter “*lowest price*”, identified in the consumer survey, was discarded for the purpose of the use case. The reason for this is that producers in the craft

sector (such as carpenters) will very likely not participate in a platform that encourages price competition as this is already an issue that they have to deal with [5]. The distance parameter will not be implemented in the first phase of ProNeD due to technical reasons, which will be detailed in the next chapter. Since the initial network will consist of only regional producers anyway, it should be sufficient to include this in future development stages with a wider network. The “*best CO₂ balance*” will be modified slightly in the beginning to accommodate the difficulties of measuring this for a single product. The chapter on sustainability standards will investigate this more in depth. The “*particularly good working environment*” and “*social commitment*” are very similar parameters, so they will be combined for easier application. The “*fastest delivery*” was among the lowest-rated parameters in terms of importance for the customers. In the technical planning system, however, the production time is calculated anyway because producer later in the value chain need to know, when they will be able to start their production process. Therefore, this parameter will be offered in the first implementation phase as an extra choice. It may later on be replaced by the shortest distance parameter.

V. PARAMETERS FOR THE INITIAL IMPLEMENTATION

As shown in Table 1, five of the seven initial VCPs will be included in the initial release of the platform. They will be presented to customers in different ways, however, and have been slightly modified for practicality and marketing purposes. This is also due to the fact that the VCPs depend on different factors, meaning some are producer-specific and thus relatively static, while others change according to the customer or the product configuration. The customers can also decide to not choose a VCP, in which case the platform will randomly select one.

A. Material-Related VCPs

The term “*use of regional materials*” was widened to “*use of sustainable materials*” since not everything can be sourced locally. Furthermore, as mentioned, this will not be selectable in the VCP options but instead in the customisable material options. Thus, this will also have a direct influence on the price of the product since the raw material prices for sustainable and ethical sourced materials are often higher.

B. Order-Specific VCPs

These VCPs are hinged on the actual order and may thus change with every new order. This makes such parameters more difficult to include technically because the VCP ratings of the possible value chains need to be recalculated for every order to select the best one depending on the current order. One example is the distance between the customer and the producer, since this changes depending on the requested delivery address. Hence, this will be implemented at a later stage in the project. For the initial launch, no order-specific VCP is included.

C. Producer-Specific VCPs

The advantage of producer-specific VCPs is that they only need to be pre-calculated once before the first order because they rarely change. To do so, every network producer needs to be evaluated and assigned a numerical value for their level of fulfilment of the producer-specific parameters. Then, ratings for each of these criteria for all possible value chains of every product can be calculated in advance. Thus, when a new order is placed, the value chain with the highest rating for the chosen parameter can be found immediately and production can be

started. A planning tool specifically for this application was also developed within the ProNeD project. For further information on the technology and mechanism of said planner, refer to [6].

The producer-specific VCPs chosen for the initial implementation are “*best CO₂ balance in product manufacturing*”, “*particularly good working conditions for employees*”, and “*special social commitment of the producers*”.

The “*best CO₂ balance in product manufacturing*” was also modified to be more inclusive of other environmentally relevant emissions and measures to minimise the use of resources such as electricity and water. The wording was thus changed to “*production with the lowest emissions and environmentally friendly production*”.

The “*particularly good working conditions for employees*” and “*special social commitment of the producers*” will be, as mentioned before, combined to “*social commitment in the region and family-friendliness*”. The difference between these parameters is not pronounced enough to differentiate them in a meaningful way.

The “*fastest delivery*” is a hybrid parameter, since it depends on the time of the order and the current open production capacities, but also on the speed at which producers can manufacture the product. This may vary significantly depending on personnel, but especially the available machines. Since the initial platform will not be capable of tracking producer capacities, this parameter is reliant on the production time predictions made by each producer. Thus, for the platform launch, this parameter can be considered producer-specific.

VI. APPLYING TRACKABLE KPIS AND MEASURABLE VARIABLES TO THE VCPS

An essential aspect of the selection of VCPs is, of course, making them transparent and assessable. This transparency is particularly important for the customer so that they understand precisely what is behind the parameter. On the other hand, the exact evaluation basis is of particular interest to the producers in order to increase the company's own value in the selection of parameters by the customer and the associated formation of the value chains; ergo to be considered more often in the selection of value chains.

A. Regulations and Standards for SMEs

To establish a solid foundation for this analysis, the current standards for fulfilling the sustainability reporting obligation have been applied analogously to the European reporting obligation. Directive 2014/95/EU from 22 October 2014, states: “The disclosure of non-financial information is a key element in managing the transition to a sustainable global economy by combining long-term profitability with social justice and environmental protection. In this context, the disclosure of non-financial information helps to measure, monitor and manage the business performance of companies and their impact on society” [7]. In this context, the term sustainability controlling is relevant. Controlling, as an umbrella term, describes the planning, control, as well as management and steering of economic processes, where key figures serve as an essential tool [8]. Accordingly, sustainability controlling includes measures for the effective management of the non-financial performance of companies and organizations, taking into account Environmental, Social and Governance (ESG) aspects. Companies and their responsibility towards society have gained significant importance [9]. This responsibility is reflected in

the documentation and disclosure of a company's individual impact on the environment in the form of a sustainability report. With the entry into force of the CSR Directive 2014/95/EU in 2017, non-financial reporting has gained increasing importance [10]. CSR stands for “Corporate Social Responsibility” [11]. The requirements for sustainability reports include at least the topics of social and employee matters, environmental issues, human rights and the fight against corruption and bribery [12].

In line with the recommendations of the CSR committees, existing frameworks that cover all the required aspects should be used for guidance. In this context, the Global Reporting Initiative (GRI) and the German Sustainability Code (DNK) should be mentioned [10]. Furthermore, the EMAS (Eco-Management and Audit Scheme) is particularly suitable for use in SMEs. It is an environmental management system introduced by the European Commission as an instrument for assessing the environmental performance of companies [13], whereby EMAS refers to Regulation (EC) 1221/2009 and came into force on 11 January 2010 [14]. The European Federation of Financial Analyst Societies (EFFAS) created a framework in 2010 that provides guidelines for incorporating ESG (environmental, social, governance) factors into financial analyses and company valuations, which are utilized in sustainability reporting [15]. The International Organization for Standardization (ISO) is a non-governmental, independent organization. It brings together expertise from its international members to promote knowledge exchange across national and regional borders, with the aim of collaboratively developing market-relevant international standards. These standards are designed to foster innovation and address global challenges [16]. Notable among the environmental and sustainability standards are ISO 14001 and ISO 26000. ISO 14001 is an internationally recognized standard for environmental management systems, providing a framework for organizations to design and continually improve their environmental performance. These standards were also considered to incorporate appropriate detailed descriptions into the VCPs.

Based on this overview, a literature review was initiated to analyse the examined standards with regard to various publications on different topics. A total number of 43 different guidelines were identified and included in the detailed analysis. The list comprises 13 titles from the GRI standard, 14 publications from the EFFAS standard, 11 publications from the EMAS standard and 5 international standards. During the initial research, it quickly became evident that both the ISO standards and the guidelines of the GRI standard place a clear focus on industrial companies. As this work is a platform for designing value chains in a network of small and medium-sized enterprises, these standards were therefore not taken into further consideration. Nevertheless, for the reason of completeness, they are presented as a whole to emphasise the accuracy of the research. Table 2 provides an overview of the sources considered. The title and a heading have been included in each considered publication or guideline in one of the stated standards. the headlines of the publications have been partially shortened for the sake of clarity.

TABLE 2: OVERVIEW OF THE VCP OPTIONS

Standard	Titel	Source
GRI 201	economic performance	[17]
GRI 205	anti-corruption	[17]
GRI 301	materials	[17]
GRI 302	Energy and water	[17]
GRI 303	water and wastewater	[17]
GRI 305	emissions	[17]
GRI 306	waste	[17]
GRI 403	health and safety at work	[17]
GRI 404	training and further education	[17]
GRI 405	diversity and equal opportunities	[17]
GRI 406	non-discrimination	[17]
GRI 414	social assessment of suppliers	[17]
GRI 415	political influence	[17]
EFFAS S06	supplier agreements /supply chain	[18]
EFFAS E13	eco-design	[18]
EFFAS V04	innovation	[18]
EFFAS E01	energy efficiency	[18]
EFFAS E04	waste scope I	[18]
EFFAS E05	waste scope II	[18]
EFFAS E02	greenhouse gas emissions	[18]
EFFAS S03	maturity of the labour force	[18]
EFFAS S10	diversity	[18]
EFFAS S02	training and qualification	[18]
EFFAS S07	certification of facilities	[18]
EFFAS G01	contributions to political parties	[18]
EFFAS V01	risks of legal disputes	[18]
EFFAS V02	corruption risks	[18]
EMAS EN	energy efficiency	[19]
EMAS M	material efficiency	[19]
EMAS W	water efficiency	[19]
EMAS A	waste	[19]
EMAS B	biodiversity	[19]
EMAS EM	emissions	[19]
EMAS Go	overall organisation	[19]
EMAS BS	procurement	[19]
EMAS PV	product responsibility and sales	[19]
EMAS Pm	human resources management	[19]
EMAS Km	communication and marketing	[19]
ISO 14001	environmental management systems EMS	[20]
ISO 14006	EMS-guidelines for [...] product design	[21]
ISO 14031	environmental performance evaluation	[22]
ISO 14050	environmental management - terms	[23]
ISO 26000	guideline on social responsibility	[24]

B. Specification of the Object

When analysing the standards, it is evident that they place a clear focus on comparability and trackability. This is understandable as they serve as the basis for reporting to a regulatory body, in this case the representative of the elected authority in which a company operates. The document therefore usually contains indicator sets that make various aspects of sustainability trackable. In general, key indicators provide quantitative information used to represent structures and processes within a company or its various areas. They summarize fundamental data into meaningful metrics. In this work, the terms key figures and performance indicators are used synonymously. These metrics are collections of numbers that often result from differentiating or summarising the outcomes of various activities or linking specific information [25]. Statistically, key figures are divided into absolute and relative figures. Absolute key figures indicate the quantitative scope of a specified quantity and provide information on how many elements this quantity consists of. In contrast, relative key figures, also known as ratios, are created by meaningfully linking facts in the form of a quotient [26]. Measurement variables, on the other hand, are to be understood as much softer, they are rather descriptions that appear in the documents and paraphrase the

selected KPIs or make them easier to understand, but at the same time also express the companies' internal endeavours to consistently improve their own sustainability.

C. Performing the Analysis

Starting with the two leading VCPs selected by the customer survey for the initial implementation, a search was now conducted for KPIs and measurement variables in the selected standards. The following have been selected:

VCP - I. Social commitment in the region and family-friendliness.

VCP - II. Production with the lowest emissions and environmentally friendly production.

For the description of the *VCP - I. Social commitment in the region and family-friendliness*, seven different parameters were selected as more detailed descriptors; these are listed in detail in Table 3, and each is coded in column 2.

TABLE 3: OVERVIEW OF THE VCP-I. OPTIONS

Overall	Code	Description
VCP - I. Social commitment in the region and family-friendliness	VCP-I / A	The company acts as a training organisation, providing comprehensive training and instruction in the relevant specialist area. The company assumes responsibility for imparting the necessary technical knowledge and practical skills required for a successful state-recognised vocational qualification.
	VCP-I / B	The company is officially involved in the regional training company in the subject area and is involved in structural, organisational or other processes to promote training across company boundaries.
	VCP-I / C	The company or entrepreneur volunteers for the guild or the Chamber of Crafts to strengthen their own speciality regionally.
	VCP-I / D	An officially authorised person working in the company acts voluntarily as an ambassador for the craftsman sector to represent the own speciality (e.g. carpenter) in this role and actively contribute to the promotion and recognition of it in society.
	VCP-I / E	The company actively contributes to the visibility of its speciality. This is achieved by offering school internships and familiarisation days for future trainees. Such measures enable prospective adults to gain an early insight into the professional requirements and activities of the speciality.
	VCP-I / F	The company is actively committed to promoting equal opportunities by, for example, pursuing the targeted promotion of diversity in the workplace, participating in initiatives such as Girls' Day, supporting socially disadvantaged people and integrating refugees.
	VCP-I / G	The company is involved regionally or nationally on a voluntary or social basis in various areas of social life. Such commitment can manifest itself in a variety of ways, for example by sponsoring jerseys for local sports clubs or actively supporting community projects by utilising the company's resources.

The following aspects, seen in Table 4, were selected to quantify *VCP - II Production with the lowest emissions and environmentally friendly production*. The tabular presentation follows the categorisation in Table 3.

TABLE 4: OVERVIEW OF THE VCP-II. OPTIONS

Overall	Code	Description
VCP - II. Production with the lowest emissions and environmentally friendly production.	VCP-II / A	The company integrates the methodologies of the 7-R principles into its business model and, by analogy, carries out value-adding activities such as repairs or maintenance when these are appropriate to its field of activity.
	VCP-II / B	The company independently takes comprehensive measures to protect the environment, developing context-specific concepts to reduce the use of resources in the value chain as well as application measures to implement these in its own organisation.
	VCP-II / C	The company develops its own concepts for ecological energy supply, for example, green electricity is purchased and measures such as the use of a photovoltaic system are part of the company's overall concept for ecological energy utilisation
	VCP-II / D	The company has a cross-value chain strategy for holistic ecological energy procurement, energy utilisation and energy feed-in. It also includes cooperation with other companies along its own value chain.
	VCP-II / E	The company is familiar with the methodologies of the 7-R principles, and is integrating the methods through, for example, an on-site energy evaluation to avoid transport, will be a sensible option if no better overall impact on increasing sustainability can be achieved through other R methodologies [27].
	VCP-II / F	As part of the internal value chain, the company pays meticulous attention to avoiding potentially environmentally harmful materials in its own value creation process and takes the utmost care when handling such materials if they are indispensable.
	VCP-II / G	The company pursues a holistic strategy to reduce the total number of journeys and transport routes required in the context of operational value creation in a structured manner, which will thus have a positive influence on the company's overall impact on the environment (traffic, CO ₂ emissions).

The seven descriptive parameters A to G for each VCP listed in Tables 3 and 4 were defined through a comparative evaluation of the relevant norms and standards that had been selected. The decision was based on the premise of maximising customer impact and selecting criteria that are easily understandable and broadly accepted by customers.

VII. SUMMARY AND OUTLOOK

As part of this scientific work, a systematic approach was discussed and implemented to identify customer-oriented sustainability criteria for value creation in local production networks of small and medium sized Enterprises (SME). The aim is to involve customers in value creation decisions at an early stage. The goal of selecting value chain parameter (VCP) for the application context and quantifying them more precisely was achieved with the approach described. The application context comprises a new type of platform concept capable of arranging value chains in a demand-oriented manner and selecting the optimum form according to requirements. As part of a pilot project, a technology offshoot of this system, Production Next Door (ProNeD), is being installed on a platform and put online. The selected value chain parameters (VCP) will therefore be trialled in reality in the near future. For the context of Production Next Door (ProNeD), four value chain parameters (VCP) were selected through a survey of potential customers. Through a successful quantification of the two producer-specific parameters by means of thorough research in the areas of sustainable corporate orientation (ISO standards)

and common EU directive-compliant sustainability reporting standards, both value chain parameters (VCP) were presented in more detail with seven descriptors. This is also a point of criticism: A finer granularity would possibly have allowed for an even better differentiation and, thus, evaluation of the companies. In general, more value chain parameters (VCP) should be implemented in the future to achieve a greater impact of customer choice. In addition, a transfer to the global reporting initiative (GRI) standard could be of interest to create a generally valid list that can be used in different application contexts. The next step is to implement the already mentioned realisation of the selected customer-oriented sustainability criteria in the new shop environment.

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