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Development Of A Method For Decision Support On Participation In Capacity Sharing For Manufacturing SMEs

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Abstract

A volatile, non-transparent market environment leads to fluctuations in the load on production capacities in the manufacturing sector, which are reflected within production in over- or underutilization of machines and persons. Small and midsized enterprises (SMEs) are expecting increasing volatility, which is accompanied by an increase in the frequency of market and economic cycles. For SMEs it is difficult to handle these fluctuations. Capacity sharing platforms can be a solution for this challenge. Platforms are available in different forms. Currently, companies are not often using this possibility, because of prevailing scepticism in different fields. Therefore, a methodology will be developed to provide a decision support for or against platform usage. Additionally, the platform type choice will be supported, and the changes of logistic and economic indicators will be considered. With this information, companies can make a qualitative decision, and the existing inhibitions can be alleviated.

Keywords

Capacity sharing; decision support; supplier and consumer view; logistic and economic indicators

1. Introduction

The digitization of the economy across industries is not only leading to the emergence of innovative products and services, but also to a transformation of existing market logics [1]. Digital platforms as a growing innovation driver of digital transformation exists [2]. By linking the sharing economy in the form of capacity sharing with digital platforms, companies can offer or purchase their free or required capacities on an inter-company basis. This potential flexibility is currently getting more and more attention. SMEs are expecting increasing volatility, which goes hand in hand with an increase in the frequency of market and economic cycles [3]. Especially for SMEs, these fluctuations are difficult to map internally, so capacity sharing is seen as a solution to compensate these fluctuations. The decision of a beneficial of using capacity sharing for an individual company and which type of platform is suitable, depends on various factors. Therefore, a methodology has been developed to help companies to make this decision. It also provides a guidance on how economic and logistic indicators would likely change by using capacity sharing. Companies can make a high-quality decision based on this provided information in a user-friendly application including a guidance [4]. *

2. State of the art

Many SMEs are currently affected by increasing workload fluctuations. The state of the art will first present, how the current way looks like to challenge these fluctuations, followed by a presentation of the current use of capacity sharing in companies.

2.1 Workload fluctuations in SMEs and current compensation

Most recently, more than a half of all German SMEs were affected by sales losses averaging 53% compared with expected sales in March 2020 [5]. The reasons for this are for example the measures to combat the pandemic or the declines in demand for orders [5]. A look at the change in production in the manufacturing sector in Germany compared with the previous month from January 2020 to 2021 shows significant fluctuations in orders and thus capacity utilization [6]. A study by GREAN GmbH in the issue of "Production after the pandemic" shows, that there is a high level of capacity utilization during the pandemic and most companies also expect a rapid recovery [7]. The high level of capacity utilization is due to an artificial reduction in available capacity, e.g. through short-time working, and to existing orders that were placed before the outbreak of the pandemic [8].

Independently of pandemics, companies are confronted with fluctuations in capacity utilization. The reasons can be found in a volatile market and the globalization [9]. Furthermore, fluctuations in capacity utilization can be influenced by the economic situation, e.g., during the financial crisis in 2009 [10]. Additionally, political conditions or natural disasters can lead to material shortages [11]. However, the sector itself also entails a certain degree of fluctuation in capacity utilization, for example due to seasonal products [12].

To counter fluctuations in capacity utilization, companies can make use of various flexibility instruments. These can include working time accounts, short-time work, temporary work, extending shift work or increasing weekly working hours [13]. Furthermore, permanent machine availability can be ensured by an in-house technical support. These measures counteract the consequences mainly by adjusting the available internal personnel capacities [13]. However, if these are fully exhausted or if no plant and machinery is available, or the disadvantages for the persons are to be abolished, the use of capacity sharing can be beneficial. This applies to the situation where free capacities are available in the own company and can therefore be offered as well as to an overload and the subsequent external assignment of orders.

2.2 Capacity sharing for SMEs in the manufacturing sector

Fluctuations in capacity utilization are increasingly challenging manufacturing companies. A digital platform makes it possible to exchange production capacities to compensate fluctuations in capacity utilization. It is possible to participate in a platform as a supplier, a consumer or both, depending on the current situation in the companies.

In the private environment, the sharing economy is becoming increasingly important. Opportunities for car sharing and platforms for renting accommodation are widely used [14]. In the industry, there are opportunities for capacity sharing, which are little used. Reasons for the restrained use can be found, for example, in the competitive situation of the companies. The decision to outsource production steps or to use a platform is often equated with the disclosure of own production ideas [15]. But it is also difficult to assess the uncertainties about the course and cost of such an order, the quality of the externally produced product or the effects on the company's own production processes.

Currently, there are several active platforms that offer different manufacturing processes such as milling, drilling, 3D printing or CAD design for different batch sizes. The possible customer groups are very diverse and cross-industry. Since the technical possibilities are available in a variety of different solutions, the companies must now be picked up, comprehensively informed, and supported.

The need for companies to be adaptable is seen and described in the literature. However, the flexibility instruments concern internal personnel, which creates only internal solutions. Due to the large number of platform providers, an external and cross-company solution could be provided. Nevertheless, this is mostly not used by SMEs because of uncertainties whether capacity sharing makes sense for the companies and which platform should be used. Furthermore, the effects on their own production are unknown. Currently, there is no scientific support for companies to decide whether the use of capacity sharing is individually useful, which capacity sharing platform is suitable and what are the effects on their production. This paper aims to fill the research gap by developing a method for decision support on participation in capacity sharing for manufacturing SMEs.

3. Decision support for the use of capacity sharing

The structure of the developed decision support is shown in figure 1.

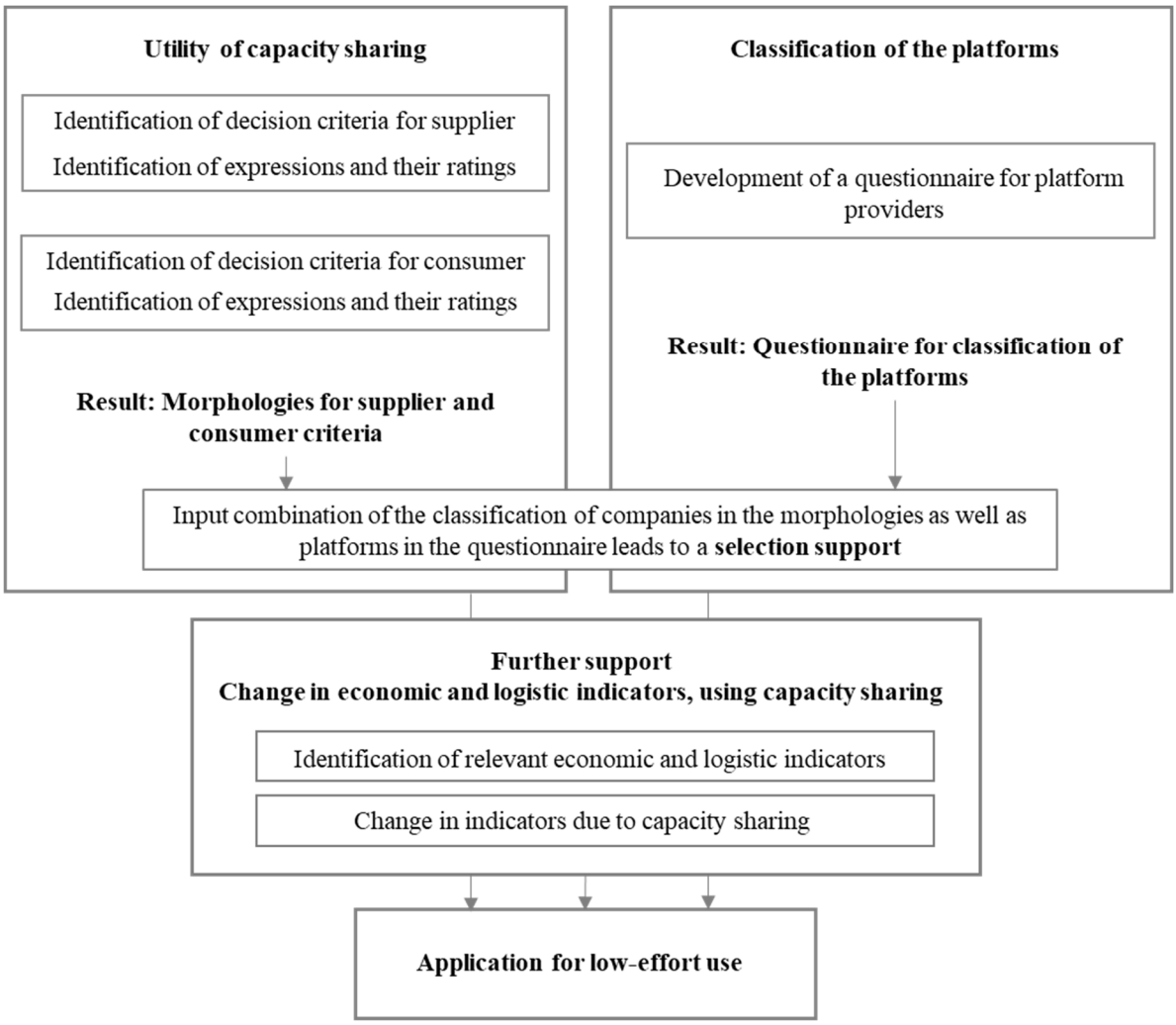

Figure 2: Structure of the methodology

To provide comprehensive decision support, the first step is to develop a methodology that can be used to evaluate, whether it is beneficial to participate in capacity sharing as a supplier/consumer. For this, decision criteria must be identified as well as their expressions and ratings. As a result, morphologies arise for supplier and consumer criteria. In a second step, support is provided to decide which platform is suitable for a company and its requirements. For this, a questionnaire must be developed for the platform providers. As a result a classification can be create for each platform. These steps can be combined to create a platform selection support. Depending on the placement of the companies to the expressions of the decision criteria

as well as the questionnaire response of the platform providers, a suitable platform can be suggested. Additionally, the change in economic and logistic indicators, arise by using capacity sharing, will be presented. Therefore, relevant economic and logistic indicators were identified and the change due to capacity sharing will be presented. In the last step, the selection support and further information will be integrated and presented in an application for a low-effort use.

3.1 Utility of capacity sharing

To evaluate participation in a capacity sharing platform, decision criteria must be defined as well as their expressions. These will be presented in a morphology. Thereby, a morphological box is created for the supplier and consumer side. Already here, attention was paid to the following task, which deals with the assignment of a suitable platform and considers criteria in this topic too.

3.1.1 Identification of decision criteria and expressions for supplier

Table 2 shows the final supplier morphology, which was developed via iterative interviews with experts[1]. The forms of expression of the individual dimensions already give an indication of which characteristics stands for (column 3) and which stands against (column 1) participating in capacity sharing platforms. The middle column shows indicators which must be considered, when selecting a capacity sharing platform, but which do not give a clear indication for or against the use, but offers properties to select a suitable platform.

The **fluctuations in demand,** postulated in this paper, are confirmed by the experts, and therefore enable temporary capacity sharing as an attractive application scenario. Also, the **willingness to increase the machine utilization** should be given. As far as the **availability of utilization data is concerned**, most of the companies do not currently have any (usable) data regarding to the utilization of individual machines. For this reason, automated a matching based on real utilization data can only be implemented in a few scenarios or by retrofitting the machines accordingly [16]. Due to the sometimes-large effort required for retrofitting and various critical security aspects about data provision, an alternative solution approach to capacity matching is the active maintenance of integrated production planning, in which corresponding slots for individual machines can be enabled or blocked.
An evaluation of the **availability of various manufacturing processes** reveals major differences, which must be considered. Discussions with the experts identified the manufacturing processes, which are currently requested via platforms or offer potential for use.
The **quantity and variety** of the raw material in inventory represents another decision dimension that must be queried in an automated matching process. Ideally, the available quantities of raw material should be read directly from a producer's system during the matching process. If an order is placed by means of individual quotations from the production partners, the check can be carried out as a part of the quotation preparation process. However, since it is not known in advance, which company has which materials and in which extent, the overall effort requires to prepare the offer increases and the efficiency of the platform suffers. It is recommended for the production partners to maintain a virtual material inventory, which can be considered during the matching.
The **infrastructure** should give the possibility to add further orders for using capacity sharing platforms. The general **flexibility** of the organization as well as the general **willingness** of the companies to support an additional platform are queried, as these characteristics represent a basic condition for the use of a capacity sharing platform.

[1] The team of experts consists of employees of manufacturing companies (5), consulting companies (3) and research institutes / associations (4) as well as platform providers (3). This team of experts is also meant in the further course of this paper.

Table 1: Supplier morphology

Characteristic		Eexpressions		
		1	2	3
Do fluctuations in demand frequently lead to temporary underutilization of machines?			no	yes
Do you have machines, whose utilization you would like to increase in general?			no	yes
Is your company's production capacity utilization data available?		unknown	unknown, not standardized	standardized, digital available
Utilization of individual production areas	Additive manufacturing (ceramic-based)	high utilization/ not relevant	overload during order peaks	low to medium Utilization
	Additive manufacturing (metal-based)	high utilization/ not relevant	overload during order peaks	low to medium Utilization
	Additive manufacturing (polymer-based)	high utilization/ not relevant	overload during order peaks	low to medium Utilization
	Sheet metal processing (laser cutting, bending, surface treatm.)	high utilization/ not relevant	overload during order peaks	low to medium Utilization
	CNC-turning	high utilization/ not relevant	overload during order peaks	low to medium Utilization
	CNC-milling	high utilization/ not relevant	overload during order peaks	low to medium Utilization
	Plastic molding (injection molding, extrusion)	high utilization/ not relevant	overload during order peaks	low to medium Utilization
	Tube processing / tube bending	high utilization/ not relevant	overload during order peaks	low to medium Utilization
	Welding	high utilization/ not relevant	overload during order peaks	low to medium Utilization
Quantity and variety of available stocked raw material for the specified manufacturing areas.		low		high
Additional orders can be added (infrastructure).		no		yes
How high do you rate the flexibility of your production planning and control system?		low		high
Personnel utilization	Construction	high		low
	Manufacturing	high		low
	Assembly	high		low
Supporting Areas	Is there a possibility in the WMS to consider additional orders?	no		yes
	How high is the effort to integrate additional orders in the material flow?	high		low
	How high is the effort to consider additional orders in the goods issue?	high		low
High number of tenders with low chance of success or few tenders with high chance of success?		many offers great competition		few, individual offers
Would you like much transparency and comparability about the processes and services of the platform?		no		yes
Knowledge/skills		Certificates not available		Certificates available

The **personnel utilization** in production represents another important decision criterion for capacity sharing. If there is a high utilization of personnel despite low utilization of individual machines, the orders must be selected in such a way that the pure production times, in which the machine works autonomously, dominate, in relation to the work preparation (setup, clamping, reclaiming, etc.). This can be achieved by particularly high machining times per part or large quantities of individual jobs. In the future, capacity sharing platforms should take this aspect into account.

In the **supporting areas**, serious differences also become apparent between companies, that manufacture their own products and contract manufacturers. While the latter have hardly any restrictions in the supporting areas and the processes are optimized for the short-term processing of external orders, the material flow-oriented organization of manufacturing companies leads to serious restrictions about capacity sharing in the supporting processes. Here, new processes often must be developed to enable the integration of new special orders into the material flow, warehouse management (WMS) and goods issue processes.
Also important is the preferred scenario about the **number of offers and the competition** as well as the availability of **transparency and comparability**, which effects the decision for one special platform.
About the **necessary knowledge and skills,** there is also a widespread among the manufacturing partners surveyed. While all potential manufacturing partners have at least one external certification (mostly ISO 9001), the companies have numerous other certifications that must be considered in the matching process. Relevant certifications exist, for example, for the automotive industry (IATF 16949), aerospace (EN 9001) or medical technology (ISO 13485). Due to liability issues across the supply chain, the central task of the platform here is to evaluate the production partners' certificates to fulfil these requirements. In table 1, the differentiation between no certificates and certificates available is shown in a simplified form. In the resulting matching, the certificates must be considered in more detail.

3.1.2 Identification of decision criteria and expressions for consumer

Table 2 presents the relevant decision criteria from the consumer perspective.

A central distinction is already provided by the question, whether the outsourcing part is a mission-critical process or a **core competence** of the company. In these cases, reservations about capacity sharing platforms are significantly greater than in the case of the production of spare parts, prototypes, or custom-made products from special mechanical engineering. In the case of the former, liability issues must be clarified (product liability, intellectual property), which is why close cooperation must be established between company's purchasing department and the capacity sharing platform.
In the indirect areas, capacity sharing platforms offer a major advantage when a company's **purchasing department** is working utilized. Through the platform, more **purchasing autonomy** can be assigned to individual departments (testing, prototype, construction), which relieves the indirect areas to some extent. Also, the experience of companies in the field of assigning **external partner** for an extern production could be a relevant indicator.
The next characteristic is about the **design data**. The digital availability, the design data quality and the format are important for the usage of a capacity sharing platform. Since all capacity sharing platforms are fully digitized, the provision of design data in step format (Standard for the Exchange of Product model data) is usually recommended or, in some cases, assumed as a minimum requirement.
The reduction of the **geographical distance** of the exchange partners is also important for many German companies. In addition to reducing costs, the **environmental protection** and support of global sustainability goals [17].
Another important decision dimension is the **characteristics of product properties** of the orders to be placed. Important is the question, whether standard or special material must be used. In addition, it is decisive, whether the manufacturing process is exclusively for a single part or whether additional assembly steps are necessary for the manufacturing of assemblies or entire products. Assembly and the associated material procurement increase the complexity of matching enormously. Furthermore, it is also decisive whether semi-finished products must be provided for production or whether the initial process step is mediated. This is important because only a few platforms have a standardized process for the provision of input material.
Important for the decision for one special platform type is the preferring **price possibilities** (instant price and comparison offers).

Table 2: Consumer morphology

Characteristic		Expressions		
		1	**2**	**3**
Core competence / success-critical process		yes		no
Utilization personnel purchasing		low		high
Would you like to increase the purchasing autonomy / flexibility of individual departments?		no		yes
Do you often need external partners to compensate for order peaks?		no		yes
Design data	Digital availability	no		yes
	Design data quality	low		high
	The data is transmitted as a step file. Should orders also be placed by means of a technical drawing (pdf)?	Partial orders via pdf		no
Importance of the environmental protection and CO^2 balance of the production partner.			not important	important
Geographical distance of production partners.			important	not important
Characteristics of potential contracts to be awarded	Order material	special material		standard material
	Produkt type	produkt	module	component
	Is special input material required?	Provision Semifinished product		no starting material/initial process step
	Heterogeneity of orders	low		high
	Average contract value of contracts to be awarded	> 10.000€	2.000 - 9.999 €	< 2.000 €
Do you prefer a binding immediate price or do you require several comparative offers?		instant price		comparison offers
Data protection/ Data security	Desired server location of the platform	Germany	Europe	worldwide
	Certification according to ISO/IEC 27001 or 27002	required	desirable	not relevant
Flexibility		low		high
Legal framework conditions (e.g. standards and certificates to be met)		available		not available

3.1.3 Usage to identify the utility of capacity sharing

The characteristic **data protection and data security** is also important, especially for the decision for one platform, as well as the **flexibility** itself.
Finally, as with any other types of outsourcing, the **legal framework conditions** must be checked to determine the extent, to which a specific component can be earmarked for outsourcing. Most platforms have a standardized non-disclosure agreement (NDA), which can be viewed in advance on the homepage.

In the next step, an individual company can select the expressions of the criteria. As a first result, the user receives a supplier and consumer score for the suitability in percent. The classification of the resulting recommendation is shown for an example in Figure 1. In discussion with experts and the first company results, by using the decision support, the borderline between the suitability and a necessary further examination was set at 30 percent. This borderline is not fixed, it represents only an orientation. In further validation steps, this borderline must be analysed in more detail.

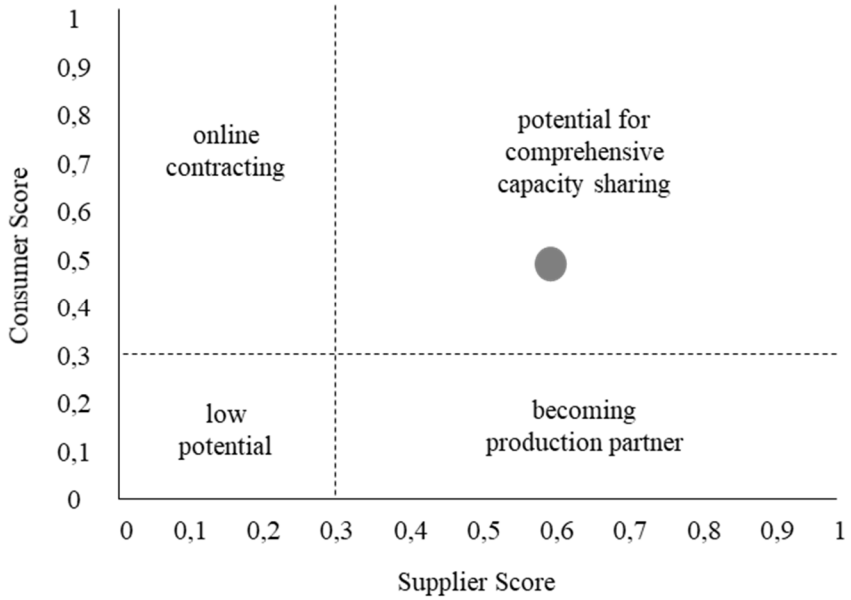

Figure 2: Illustration of the suitability for capacity sharing

In the present example, capacity sharing offers a great potential for the company, whereby the company can act as a supply and a consumer.

3.2 Classifications of the platforms

For the identification of the decision criteria for a platform type, the previously identified criteria were used as a basis. The two task areas were worked through in parallel, so that the companies do not have to provide any additional information. In consultation with platform providers, the differentiation possibilities of the platforms were worked out and integrated into the morphologies. The platform providers get a questionnaire, where they can provide information about their platforms. The following information should be provided by the platform providers:

- Supporting manufacturing types of the platform: additive manufacturing (ceramic-based, metal-based, and polymer-based), sheet metal working, CNC turning, CNC milling, plastics processing, tube processing, welding
- Supplier and consumer role possibilities
- Manufacturing of assemblies and/or individual products and/or individual work steps
- Preferred order volume
- Instant quotes / tender platform
- Transparency (e.g. FAQ)
- Orders via PDF possibility
- CO^2 neutrality
- Server location / data security (choose between: Germany, Europe, worldwide)
- ISO /IEC 27001 or 27002 - certifications (choice between: mandatory, desirable, not required)
- Hypertext Transfer, Protocol Secure (HTTPS) available

Based on the classification of the companies into the morphological boxes presented above and the answers to the questionnaire of the platform providers, an individual suitability to the platforms (in percent) can be determined. An actual overview of the platform providers was made available for this purpose.

3.3 Change in economic and logistic indicators, using capacity sharing

For the final evaluation, whether participation in a capacity sharing platform is beneficial for a company, the companies should know, how their economic and logistic indicators are likely to change. For this purpose, the relevant indicators were identified in a first step and ranked according to the strength of a possible change. In a second step, the changes for supplier and consumer were analysed, depending on the company scenario or initial situation. For this purpose, standard scenarios were developed with experts, for each of them the anticipated changes can be worked out.

3.3.1 Identification of relevant economic and logistic indicators

To identify the relevant economic and logistic indicators, all economic and logistic indicators were first provided. A list of relevant indicators for capacity sharing was then compiled with the involvement of experts (Table 3).

Table 3: Relevant economic and logistic indicators

economic indicators	logistic indicators
transport costs	delivery time
planning and control costs	downtime
storage costs	throughput time
production costs	delivery reliability
igle capacity costs	machine utilization
quality costs	personnel utilization
	inventory
	batch size
	setup time

The delivery time indicates the period of time that elapses from the placing of the order to its fulfilment [18]. Downtimes include technical malfunctions and other downtimes that were not scheduled [19]. **Throughput time** indicates the amount of time required from the start of production to completion. This includes idle time, setup time and processing time, as well as transport time, which reflects the distance between two workplaces [20, 21]. The adherence to promised delivery dates is described by the key figure **delivery reliability** [22]. **Machine utilization** indicates the ratio of actual machine working time to total available working time. The **personnel utilization** expresses the utilized personnel capacity in relation to the available working time [19]. **Inventories** give rise on the one hand to capital commitment costs, since goods held in inventory have to be financed, and on the other hand to storage costs [22]. The **batch size** is the quantity of products or parts that can be produced directly one after another without interrupting production [23]. **Setup time** is the time required to prepare a machine for the production of another variant [19].

Logistics costs are caused by the provision of a logistic service. In this paper, it includes the three superordinate service areas: **Transportation, storage and production planning and control (PPC)**, which are considered individually due to the different influences and anticipated changes. Transportation costs are classified as the costs incurred by the spatial change of goods. Storage costs are represented by warehousing, storage, and retrieval as well as the provision of storage space. PPC costs are incurred due to the rescheduling effort involved in taking on placing external orders [22, 18]. **Production costs** describe direct costs due to processing as well as maintenance, workshop and production performance costs [19]. **Idle capacity costs** arise from the non-utilization of existing capacity and therefore also reflect a certain degree of underemployment [24]. **Quality costs** arise from quality assurance or the restoration of the required quality through rework [19].

After identifying the relevant indicators, the next step is to assess the potential change itself. Some indicators are likely to change more than others, when capacity sharing is used. Table 4 shows the classification into high, medium, and low. This classification was made by discussions with experts.

These indicators can lead to both a positive and a negative change. It depends on the scenario or the present situation of a company as well as the role (supplier and/or consumer).

Table 4: Classification of indicators according to the strength of a possible change

high	medium	low
planning and control costs	production costs	storage costs
igle capacity costs	delivery reliabilty	inventory
machine utilization	batch size	
personnel utilization	setup time	
delivery time	quality costs	
downtime		
throughput time		

3.3.2 Change in indicators due to capacity sharing

To be able to finally evaluate the participation in a capacity sharing platform, the resulting changes in the economic and logistic indicators should be known. For the evaluation of these, a spreadsheet was developed, where the respective change for supplier and consumer, depending on the scenario or initial situation, is shown. For this purpose, expert interviews were conducted with users and capacity sharing platform holders. In total, the experts identified 10 different scenarios. Furthermore, a simulation model was built to show the changes in a simulative way to confirm the previously assumed changes. To illustrate the changes in this paper, a standard scenario is considered below that describes a manufacturing company that can act as a supplier and a consumer. The company uses the platform to compensate their seasonal fluctuations in orders. In addition, internal company influences are described that can affect the strength of the change.

The **transport costs** for the supplier or consumer increase due to the distance of the partner company and the additional transport effort. The product itself is a factor in the level of these costs. The bulkiness, volume and weight of a product are decisive factors. Another factor is the transport infrastructure between the partner companies.
The **PPC** costs increase in the supplier process and the consumer process, since the additional orders must be adjusted in the PPC. One factor for the level of this influence is the presence of system support, e.g., ERP or ME systems [25].
The behaviour of **storage costs** itself for the supplier and consumer does not normally differ from the original situation, but the capital commitment cost can be optimized.
The **production costs** for the supplier for additional orders are normally unchanged from the normal production costs of an own order, furthermore the fixed costs recovery can be optimized. Factors according to the strength of the change results is the number of additional orders as well as the deviations from the own products. The costs for the production as a consumer, in comparison with the own production, will be higher.
The suppliers' **idle capacity costs** can be drastically reduced. For a consumer, the idle capacity costs are already very low, when an outsourcing is used.
The **quality costs** for the suppliers normally remain unchanged. Only an additional necessary control could increase the costs. Increasing quality costs are likely to be incurred for the consumer, if the products are not shipped directly to their customer. After receipt of the products, they are checked in more detail before being further processed or shipped.
Participation can potentially have a negative impact on the **delivery time** of the supplier's own products. Therefore, additional orders should only be accepted, if the own production flow will not be negatively influenced. Buyers cannot manufacture the products themselves or only with long waiting times, which is why the delivery time at the consumer side should be reduced to the initial situation.
The suppliers' **downtimes** should not be different compared to their own products. For the consumer, the situation can be different. The company can compensate the downtimes by placing orders externally.

Throughput times and **delivery reliability** behave in the same way as delivery times.
Machine utilization can be increased by participation in capacity platforms for the supplier. From the consumer perspective, capacity utilization is already very good, which is why no change is assumed.
The **personnel utilization** behaves simultaneously to the machine utilization.
The **inventories** itself will be higher from the supplier view. In the event of seasonal fluctuations, participation in capacity platforms can smooth out the inventories for the supplier, so that a constant level of inventories can exist throughout the year and the ordering cycle can remain constant. The consumer's inventories remain unchanged if no additional steps to the actual process is needed, except for the material, which is now used or available at the partner's company.
The supplier can optimize the **batch size** and thus indirectly optimize the production. An internal influencing factor is the company's own current order situation and the potential for combining internal and external orders into combined batches. For the consumer, the batch size does not change.
The last indicator is the **setup time**, which can increase for the supplier, but does not have to. The difference between in-house and external orders is not clear. Normally, no changes are expected for the consumer.

3.4 Application of the methodology and validation

A methodology was developed to support the decision-making process of companies, participating in a capacity sharing platform. This methodology can be used to support the utility of participation and the subsequent platform selection. In addition, changes in economic and logistic indicators were presented.
In the last step, this methodology will be transferred in a user-friendly application tool. In an Excel sheet, companies can specify their current situation according to the morphologies and receive information on the utility of participation, expressed as a percentage. An assignment to possible platforms will be provided in this Excel tool too. Further information on the changes in the indicators is also presented in this tool, depending on the initial scenario of a company. For this, the companies must choose a suitable scenario for their actual situation.
In addition to the implementation in an application, a guidance was developed. It presents the application and describes how to use it, as well as providing the basics of capacity sharing and further information on the platforms, which are available on the market. The companies can, without any research effort, recognize, whether participation is beneficial for them, as well as receive a pre-selection for possible platforms and view the expected changes of the economic and logistic indicators.

The methodology was developed with the input and discussions of experts, so that a constant scrutiny and validation of the sub steps has taken place. To validate the total methodology, the described questionnaire was sent to platform providers. The questionnaires were processed and returned from above 20 platform providers in a short time, which present the importance of this topic as well as a low-effort processing of the questionnaire. The manufacturing companies of the expert teams test the application afterwards. The results were discussed with the hole expert team, with the result, that in these cases, the methodology gives a good support. Further detailed validation steps must be done next.

4. Conclusion and outlook

The presented methodology as well as the implementation in an application and the provision of a guidance for the decision support, for or against a participation in capacity sharing, helps companies to deal with the topic and to be able to make individual decisions. The need for more flexibility due to order fluctuations is more important nowadays to survive in the market, and companies are aware of this. The market already provides several platforms that can be used. Nevertheless, there is currently a great deal of scepticism. Companies are unsure, whether participation is beneficial for them, which platform is suitable and what changes can be expected. This can be counteracted with the presented approaches. For the long-term use of

these approaches, it is important to regularly check the platform market to include new market participants. In this way, the support can remain up to date and continue to help companies make decisions in the future.

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