



**HAL**  
open science

# Improving Forecasting Capability and Capacity Utilization in Less Digitized Industries Through Participation in the Platform Economy

Jonas Müller, Julian Lassen, Gerrit Hoeborn, Ruben Conrad, Volker Stich,  
Nick Lober

► **To cite this version:**

Jonas Müller, Julian Lassen, Gerrit Hoeborn, Ruben Conrad, Volker Stich, et al.. Improving Forecasting Capability and Capacity Utilization in Less Digitized Industries Through Participation in the Platform Economy. 23th Working Conference on Virtual Enterprises (PRO-VE), Sep 2022, Lisbon, Portugal. pp.141-150, 10.1007/978-3-031-14844-6\_12 . hal-04642025

**HAL Id: hal-04642025**

**<https://inria.hal.science/hal-04642025v1>**

Submitted on 9 Jul 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License



This document is the original author manuscript of a paper submitted to an IFIP conference proceedings or other IFIP publication by Springer Nature. As such, there may be some differences in the official published version of the paper. Such differences, if any, are usually due to reformatting during preparation for publication or minor corrections made by the author(s) during final proofreading of the publication manuscript.

# Improving Forecasting Capability and Capacity Utilization in Less Digitized Industries Through Participation in the Platform Economy

Jonas Müller<sup>1</sup>, Julian Lassen<sup>2</sup>, Gerrit Hoeborn<sup>1</sup>, Ruben Conrad<sup>1</sup>,  
Volker Stich<sup>1</sup>, Nick Lober<sup>1</sup>

<sup>1</sup>FIR e. V. an der RWTH Aachen, Germany

<sup>2</sup>Institute of Mineral Resources Engineering (MRE) RWTH Aachen, Germany  
{Jonas.Mueller, Hb, Co, St, Lr9}@fir.rwth-aachen.de; Lassen@mre.rwth-aachen.de

**Abstract.** While digitization is a strategic advantage in numerous industries such as the automotive industry or mechanical engineering, other industries like the German quarrying industry have not yet established a transformation towards a digitized industry. This leads to inefficient work and inaccurate forecasting capabilities. To address these challenges, digital platforms can incentivize digitization by supporting the capacity utilization and forecasting capability of these companies. In this paper, the quarrying industry is analyzed by a morphology and different types of companies are identified. Knowing the digital maturity of these companies and by determining the key factors to forecast demands and the capacity utilization, different operating models are derived. Combined with a morphology and the value creation system, different scenarios for the identification of platform services are examined. These scenarios are weighted in a utility analysis to get an operating model blueprint to develop and establish digital platforms in less digitized industries.

**Keywords:** Platform economy, operating models, digitization, quarrying industry, forecasting capability, optimized capacity utilization

## 1 Introduction

Many industries, such as mechanical engineering, have been continuously and successively transformed by automation and networking over the past decades. Digitization is an important part of the corporate strategy of companies in these highly developed industries [1]. In addition to the emergence of new, innovative products and services, it has helped to fundamentally change operating principles in these markets. A fundamental driver of this development is the platform economy [2]. In the past decades, the (German) quarrying industry has shown no general trend toward digital transformation [3]. Digital technologies are only integrated to a limited extent due to the industry structure: only a regional market within a 50 km radius is usually served, and more than 40 % of the companies have less than 10 employees [4]. In addition to the use of conventional technologies and insufficient data management, companies in the industry suffer from fluctuations in demand and poor forecasting ability [5].

A suitable platform solution, coupled with the specific capability of suitable data management, can support companies in the industry by improving their forecasting capability and increasing their capacity utilization. The market transparency created comes with advantages for suppliers and buyers and additionally empowers companies to optimize capacity utilization in their operations, which at the same time allows them to act more economically and sustainably.

In this paper, a methodology for a suitable operator model to offer forecasting and capacity utilization optimization services is developed. This enables companies to forecast fluctuating demand more precisely and to react to it with higher capacity utilization. This addresses the structural problem towards digitization in the German quarrying industry with the aim of creating an opportunity for the companies to benefit from the platform economy using a platform solution. The remainder of the paper is organized as follows. Section 2 reviews the relevant theoretical background, and section 3 presents the methodology and study design. Section 4 shows the methodology for establishing a platform operator model. In section 5, the conclusion is provided.

## **2 Theoretical Background**

### **2.1 Platforms and Platform Ecosystems**

In the past decades, digital transformation has significantly changed how firms operate and interact [6]. New business models appeared due to the ubiquity of data storage and processing power available [7]. A new environment for collaboration emerged, forming complex inter-organizational structures. Organizational borders become blurry and value creation is distributed across different actors [8]. Platforms are a new type of value creation systems leveraging these developments. Platforms are an “open architecture with rules of governance designed to facilitate interactions” [9]. The open architecture enables third parties to participate [9] and is the basis for building a platform ecosystem. Existing approaches support the strategic design of ecosystems (e. g. [10]), but mainly focus on transactional platforms (e. g. Amazon, eBay).

Platforms can be differentiated by their purpose and functionality. Whilst digital transactional platforms focus on their role as an intermediate to enable a marketplace, data-centric digital platforms enable the data-based connectivity of different entities. Through a digital data-centric platform, a data-based system is created in which complementary products and services are linked to form a connected overall system, a digital ecosystem [11]. Those platforms are most widely used to connect different entities’ respective businesses and therefore are mostly B2B platforms.

### **2.2 Operating Models for Platforms**

The strategy, architecture, and operational actions of platforms are significantly shaped by the underlying operator concept and influence the value proposition [12]. The operator concept of platforms is based on the two central roles, the platform sponsor

and the platform manager. The platform sponsor is the owner of the intellectual property of the platform and defines the strategy, target groups, value proposition, and governance [13]. The platform manager acts operationally in the daily business. He also provides the necessary platform components to realize the value proposition [14].

The roles of platform sponsor and platform manager can be fulfilled by one or more organizations. This creates a design space of the operator concept, which contains four prototypical operator models. In the **proprietary model**, both roles are fulfilled by the same organization. Within the framework of this operator model, extraordinary market positions comparable to monopolistic positions are achievable. However, a substantial initial investment on the part of the operators is necessary to achieve this outstanding market position. The **operator scenario** of the joint venture is created by the merger of several organizations on a normative and strategic level, which cooperatively act as shareholders for this joint venture. The joint venture acts largely independently at the operational level distributing the risks of the initial investment evenly among the shareholders. However, this operator model lacks agility at the strategic level after the initial market positioning. Multiple and conflicting shareholder interests can reduce the speed of decision-making. In a **licensing model** with one platform sponsor and multiple platform managers, aggregated customer networks of different organizations prove to be advantageous for the management side. The licensing of several managers, who provide users with access to the platform through various technical solutions, creates competition between the platform managers, which leads to attractive pricing for the platform users. However, this operator model reduces the revenue potential for the sponsor and manager. The **shared model** is created by integrating numerous organizations at the sponsor and management levels. Due to the multitude of actors, a uniform realization is difficult. The openness of these platforms enables low-cost structures. However, revenue potentials for platform sponsors and managers are low and decision-making is significantly more difficult [2].

The normative and strategic platform orientation, therefore, depends on the structural framework defined by the outlined operator scenarios and the specific occupation of the individual roles. This is a critical aspect regarding platform evolution and the offering of various platform services [15].

### 3 Methodology and Study Design

In the following, methodical foundations for establishing a platform operator model are explained. The action research methodology is a management research approach to bring about a productive synthesis between science and management consulting and meet the requirements of theory and practice [16]. The morphological method is a systematic heuristic creativity technique to systematize inventions. The central element of morphology is the morphological box. First, the problem at hand must be analyzed, then it is fragmented into relevant parameters. These parameters are constituent features of the problem at hand. Subsequently, possible characteristics are identified for each parameter. The characteristic values represent solution variants, from which a preferred solution variant is selected based on a value standard [17].

The utility analysis is a method for the systematic preparation of decisions based on evaluations (benefits) and a selection (ranking of benefits) of optimal alternatives [18]. The degree of fulfillment of each partial benefit is added up to the total benefit [19].

Qualitative interviews allow the capture of rich data but must be carefully conducted to achieve high-quality results [20]. Depending on the interview design, there are several types of qualitative interviews. In this paper, the semi-structured interview is used. The semi-structured interview is held with both prepared questions and improvised questions with a free conversation [20]. This type of interview is following a general outline to gather the necessary information but also gives the researcher enough room to adapt to the interviewees to gather more detailed results [21].

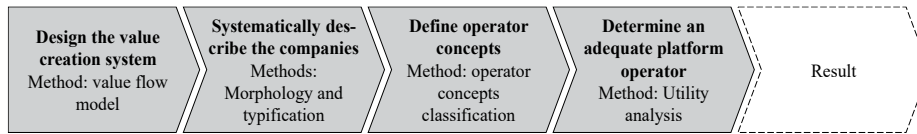
The development and validation of the methodology developed in the paper consider the use of the above-mentioned methods. A rigorous literature review is the starting point for the development of the models, the whole method was validated by 35 experts in several workshops between April 2021 and March 2022.

## 4 Results

### 4.1 Methodology for Establishing a Platform Operator Model

The paper proposes a methodology to identify different operator models for the operation of a platform in a less digitized industry. A literature review reveals a lot of research for high digitized industries (e. g. [6, 7, 11, 12]), therefore high digitization within the companies is often assumed. The structure of less digitized industries – as described in section 1 – is very different and leads to the fact that there is hardly any penetration of digital platforms, especially for forecasting and capacity services [22].

To tackle this, a methodology with several steps is developed and explained with an example of the German quarrying industry. For the development, an action research framework is used [16]. Firstly, the value creation system must be designed, the proposed method to use is the value flow model. Secondly, the companies of the industry must be systematically described and characterized. For this, methods like morphology and typification can be used. Thirdly, possible operator concepts have to be identified, they orchestrate the individual actors and define the strategy, the services, and the governance of the platform. For this, a method like the operator concepts classification should be used. Concludingly, an adequate platform operator to offer possible services for the improvement of the forecasting capability and the capacity utilization is determined. The proposed method is a utility analysis, which as a result shows suitable services in dependence on a specific operator. The methodology with the proposed steps and methods is depicted in Fig. 1.



**Fig. 1.** Methodology for establishing a platform operator model and suitable services

#### 4.2 Platform Operator Model for a Less Digitized Industry like Quarrying Industry

In this section, the different steps for the platform operator model are explained and evaluated with the example of the German quarrying industry.

**Value Creation System.** Value creation systems consist of complementary nodes and links which enable the interaction between each other [23]. Methods like the “Value Flow Model” provide the possibility to visualize the different roles, their functions, activities, and their core transactions [24]. The value creation system developed focuses on the abstract visualization of the ecosystem from an economic perspective.

The value creation system of the German quarrying industry consists of 15 different roles and their transactional relationships. Raw material extraction companies, which extract large quantities of material, are at the beginning of the value chain [25]. Taking into consideration, that the generally moderately priced (low priced) extracted goods are characteristic by high mass and volume, the transportation distance to the economically accessible market is limited to approximately 50 km [26]. Essentially, a distinction can be made between the extraction of solid rocks (natural stones) and loose rocks (sand & gravel, clay), mostly in opencast mines [27].

For the considered companies, the products are mostly used in the construction industry (approx. 95 %). Core areas of the building materials industry are building materials production, building materials recycling, building materials landfilling, and recycling, which are often directly downstream. The remainder is used in different industries such as paper, glass, food, chemicals, fertilizers, iron and steel, and others. Therefore, there are assorted primary products as well as diverse customers [28]. Entrepreneurs or groups of companies fulfill several roles in the value network. A clear demarcation between participants in the building materials industry is therefore becoming increasingly difficult. The products are distributed to consumers and returned as secondary raw materials or as waste materials deriving from demolition and recycling. The transportation occurs either directly, or by means of distribution companies. Machinery and plant manufacturers, as well as blasting service providers, enable the companies to add value. Logistics providers add value by distributing products and waste. Value creation in the industry is regulated by law and standards, public authorities, and auditors. Auditors and testing laboratories ensure the quality of the products. The value creation system is depicted in Fig. 2.

**Morphology and Typification of the Companies in the Quarrying Industry.** To ensure an adequate application of the morphological method for the characterization

and identification of the industry participants of the quarrying industry, a structured decomposition of the problem must be performed. For this, the St. Gallen Management Model can be used as it provides a method to classify a company by key categories [29]. Following the adaptation to manufacturing companies, these key categories can be broken down into in-plant and out-of-plant issues. For the morphology, the dimensions of corporate structure and digital maturity are taken, whereas the focus is on digital maturity [30]. The features and characteristics are derived based on a literature review and were validated in expert interviews (Fig. 3).

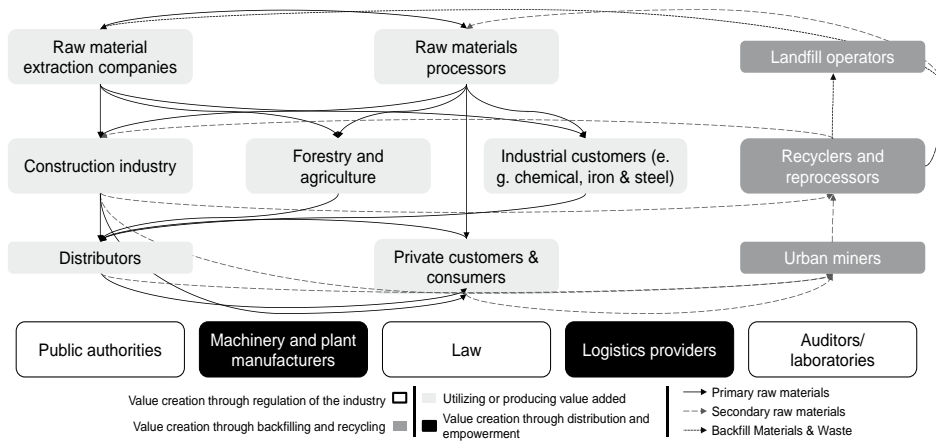


Fig. 2. Value creation system of the German quarrying industry

**Type I "Digitally expandable":** This type can particularly be assigned to micro-enterprises and predominantly small groups of companies with annual sales of up to €50 million. They employ less than 100 employees and have less than 5 locations. In the area of digital maturity, the companies work predominantly analog. Data analysis is carried out manually and not on a digital basis. In addition, it was found that recorded data on sales volumes are not evaluated, as the companies operate almost entirely demand-driven. As a result, decisions are made based on experience.

**Type II "digitally advanced":** This type can be assigned to company alliances with up to €150 million in sales, which have up to 20 locations and up to 250 employees. In terms of digital maturity, type II companies record process and status data digitally and automatically using manufacturer platforms. The use of such digital systems enables data to be fed into the internal IT network and diagnostic data analysis. Past events can be looked at intensively to clarify causes and to derive consequences for the future.

**Type III "digital pioneers":** In particular, corporations with annual sales of €50 million or more, more than 20 locations, and more than 250 employees can be assigned to Type III. Process and condition data are collected digitally-automatically via the producer platforms and are partially analyzed descriptively and diagnostically. Available assistance systems cover a wide range, including weighing systems, production monitoring and planning, Excel-based analysis systems, and Material Requirements Planning (MRP II) and Enterprise Resource Planning (ERP) systems.



**Operator Concept for the Digital Platform Solution.** To identify possible operator models, it is essential to consider the corresponding value network. In addition to private-sector players, the public sector in the form of topic-related authorities as well as associations and cooperative players, for example in the form of industry associations, must also be considered. The number of potential platform operators identified is reduced based on criteria to be selected on an industry-specific basis. By applying the criteria of digital *competencies*, *technical competencies* (mining and mechanical engineering), *network*, *neutrality*, and *profit orientation*, the potential operator candidates of the *industry association*, a *compendium of equipment manufacturers*, *technology*, and *service providers* as well as a *compendium of*

Company structure	Organizational form	Small Enterprise		Business association		Corporation		
	Revenue	< €2 Mio.	< €10 Mio.	< €50 Mio.	< €150 Mio.	> €150 Mio.		
	Number of employees	<10	<20	<50	<100	<250	>250	
Digital Maturity	Method of data collection	Analog		Digital (manual)		Digital (automatically)		
	Type of connection	None		Object	Application system		Platform	
	Type of connectivity	None / analog			Wired		Wireless	
	Type of data acquisition	Manual acquisition of condition data		Acquisition of localization data	Acquisition of condition data		Acquisition of user data	
	Type of data analysis	Manual		Descriptive	Diagnostic	Predictive		Prescriptive
	Digital assistance systems	Production monitoring		Production planning	Excel-based analysis systems		MRP II / ERP	CRM

**Fig. 3.** Morphology for less digitized industries at the example of quarrying industry

*companies in the quarrying industry* could be identified for the German quarrying industry. The latter would appear in the realization both on the operator level and on the customer level. Furthermore, *downstream players in the value chain* can be considered since the resources used in the primary extraction of bulk raw materials and the downstream construction industry are to a significant extent congruent and the use case of the platform is transferable. In addition, they know the challenges of forecasting and capacity utilization and can address them with proposed solutions. [31].

These identified and filtered candidates are now integrated into the abstracted operator models. After a comparison of the interests of the stakeholder group on the operator side and the user side, five scenarios could be identified. In a further filtering stage, by comparing the interests of the individual stakeholders at the operator and user level, the number of scenarios was reduced to three. These remaining scenarios are presented in Fig. 4 below and classified in the abstracted matrix of operator scenarios.

**Scenario 1 "Joint venture":** A union of the corporate associations of the quarrying industry, equipment manufacturers, technology providers, and service providers as well as, if applicable, downstream players in the value chain at the sponsor level realize a joint spin-off in the form of a joint venture for the operational design and management.

**Scenario 2: "Shared model":** A compendium of companies from the quarrying industry, equipment manufacturers, technology providers, service providers, and downstream players in the value chain defines a standard for sensor-captured data at the sponsor level, as well as standardized APIs to make generated data fully usable. This standard provides the foundation for a company-specific implementation of decentralized platforms, which can be carried out by a variety of independent technology providers and service providers.

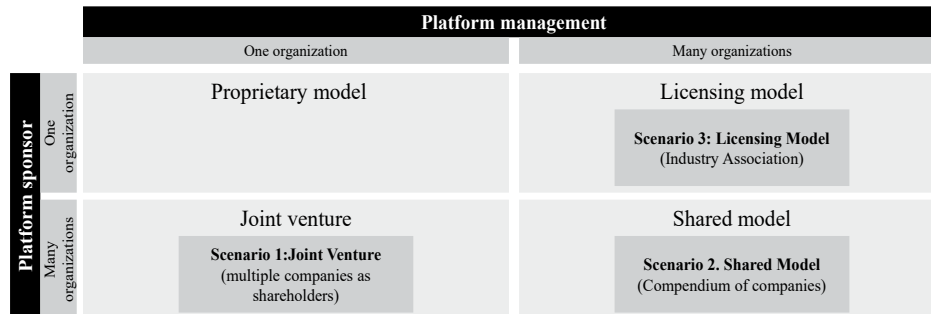


Fig. 4. Classification of operator concepts (adapted from [2])

**Scenario 3 "Licensing model"**: The industry association of the German quarrying industry acts on the sponsor level of the operator model and provides a central platform. Furthermore, equipment manufacturers and technology providers, and service providers are licensed and enable the companies to participate in the platform by providing the technical basis at the equipment level.

A final scenario-based utility analysis, with the evaluation dimensions of *added value* and *feasibility* of the individual platform services in the respective operator scenarios, enables the development of a final recommendation. Based on literature research, possible platform services are identified, which are then assigned a respective added value through expert interviews with industry participants using the methodology of pairwise comparison. The development of the second dimension, the feasibility of the individual services in the respective operator scenario, is also based on consultations with industry participants from the quarrying industry and digital transformation experts. The recommendation made by the utility value analysis, based on the procedure of the study, is the implementation of the platform solution through **scenario 3 "Licensing model"**, which is orchestrated by the industry association as platform sponsor.

## 5 Discussion and Conclusion

The developed procedural model for identifying suitable services for capacity utilization and increasing forecasting capability was explained using the example of the German quarrying industry. It was shown that initial obstacles in digital infrastructure are particularly high in this less digitized industry and reservations about profit-oriented operator models represent a significant hurdle. The approach provides a step-for-step guide to establish a platform operator model. The four steps, consisting of the design of the value creation system, the analysis of the stakeholder regarding their digitization, the identification of possible operator concepts, and the determination of an adequate platform operator help to realize suitable services for capacity utilization and increasing forecasting capability. With the detailed procedure, it is suitable for practitioners.

The study showed that the industry association, as a neutral body, is predestined to play the role of orchestrator and sponsor in linking the platform participants at the consumer, producer, and management levels. It can be assumed that these findings can be transferred to structurally comparable industries with a low level of digitization. However, the proof that the developed operator model of the platform is a blueprint for further structure-similar industries is to be led in the next step.

**Acknowledgements.** The research project 21480 N is funded by the AiF within the framework of the program for the promotion of joint industrial research (IGF) of the Federal Ministry of Economics and Climate based on a resolution of the German Bundestag. Any opinions, findings, and recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the correspondent institutions.

## References

1. Thurner M, Glauner P (2020) Digitalization in Mechanical Engineering. In: Glauner P, Plugmann P (eds) Innovative Technologies for Market Leadership. Springer International Publishing, pp 107–117
2. Parker G, van Alstyne M, Choudary SP (2016) Platform revolution: How networked markets are transforming the economy - and how to make them work for you, First edition. W.W. Norton & Company, New York, London
3. Deloitte (2018) Tracking the trends 2018: The top 10 issues shaping mining in the year ahead
4. Braun T, Hennig A (2016) Untersuchungen zur Betriebsstruktur deutscher Natursteintagebaue. Berg Huettenmaenn Monatshefte 161:181–186
5. Agrawal AK, Krishnamoorthy G (2017) Tomorrow's mine: How digital can shape the future?
6. Hanelt A, Bohnsack R, Marz D et al. (2021) A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change. *J Management Studies* 58:1159–1197. <https://doi.org/10.1111/joms.12639>
7. Volberda HW, Khanagha S, Baden-Fuller C et al. (2021) Strategizing in a digital world: Overcoming cognitive barriers, reconfiguring routines and introducing new organizational forms. *Long Range Planning* 54:102110. <https://doi.org/10.1016/j.lrp.2021.102110>
8. Siaw CA, Sarpong D (2021) Dynamic exchange capabilities for value co-creation in ecosystems. *Journal of Business Research* 134:493–506. <https://doi.org/10.1016/j.jbusres.2021.05.060>
9. Jacobides MG, Sundararajan A, van Alstyne M (2019) Platforms and Ecosystems: Enabling the Digital Economy
10. Wieninger S, Gotzen R, Gudergan G et al. (2019) The strategic analysis of business ecosystems : New conception and practical application of a research approach. In: Co-creating our future: scaling-up innovation capacities through the design and engineering of immersive, collaborative, empathic and cognitive systems: 2019 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC) : Sophia Antipolis Innovation Park, France, 17-19 June 2019. IEEE, Piscataway, NJ, pp 1–8
11. von Engelhardt, Sebastian, Wangler et al. (2017) Eigenschaften und Erfolgsfaktoren

- digitaler Plattformen: Eine Studie im Rahmen der Begleitforschung zum Technologieprogramm AUTONOMIK für Industrie 4.0 des Bundesministeriums für Wirtschaft und Energie
12. Meier P (2018) Digitale Plattformen als Innovationstreiber. In: Plugmann P (ed) Innovationsumgebungen gestalten: Impulse für Start-ups und etablierte Unternehmen im globalen Wettbewerb. Springer Gabler, Wiesbaden, Heidelberg, pp 207–217
  13. Eisenmann TR, Parker G, van Alstyne MW (2008) Opening Platforms: How, When and Why? SSRN Journal:131–162
  14. Niebuer A, Bender P (2020) Akteure und Rollen – Wer macht was bei plattformbasierten Ökosystemen?
  15. Gawer A, Cusumano MA (2014) Industry Platforms and Ecosystem Innovation. *Journal of Product Innovation Management* 31:417–433
  16. Kemmis S, McTaggart R, Nixon R (2014) *The Action Research Planner*. Springer Singapore, Singapore
  17. Zwicky F (1967) The Morphological Approach to Discovery, Invention, Research and Construction. In: Zwicky F, Wilson AG (eds) *New Methods of Thought and Procedure*. Springer Berlin Heidelberg, Berlin, Heidelberg, pp 273–297
  18. Dittmer G (1995) Nutzwertanalyse. In: Dittmer G (ed) *Managen mit Methode: Instrumente für individuelle Lösungen*. Gabler, Wiesbaden, pp 43–56
  19. Thormählen T (1977) *Der Nutzwert der Nutzwertanalyse*
  20. Myers MD, Newman M (2007) The qualitative interview in IS research: Examining the craft. *Information and Organization* 17:2–26. <https://doi.org/10.1016/j.infoandorg.2006.11.001>
  21. Liebold R, Trinczek R (2009) Experteninterview. In: Kühl S, Strodtholz P, Taffertshofer A (eds) *Handbuch Methoden der Organisationsforschung*. VS Verlag für Sozialwissenschaften, Wiesbaden, pp 32–56
  22. Schober K-S, Hoff P, Nölling K (2016) Digitalisierung der Bauwirtschaft: Der europäische Weg zu "Construction 4.0".
  23. Peppard J, Rylander A (2006) From Value Chain to Value Network. *European Management Journal* 24:128–141. <https://doi.org/10.1016/j.emj.2006.03.003>
  24. Ouden E den (2012) *Innovation Design*. Springer London, London
  25. Grömling M (2016) *Volkswirtschaftliches Portrait der deutschen Baustoffindustrie*, Berlin
  26. Grömling M (2011) *Volkswirtschaftliches Porträt der deutschen Baustoffindustrie*, Berlin
  27. MIRO (2020) *Die deutsche Gesteinsindustrie: Wirtschaft – Produktion – Anspruch. Bericht der Geschäftsführung*, Berlin
  28. Baier M, Bookhagen B, Eicke C et al. (2021) *Deutschland – Rohstoffsituation 2020*
  29. Rüegg-Stürm J, Grand S (2015) *The St. Galler management modell*. Haupt, Bern
  30. Schuh G (2011) *Strategie und Management produzierender Unternehmen: Handbuch Produktion und Management 1*. SpringerLink Bücher. Springer Berlin Heidelberg, Berlin, Heidelberg
  31. Basten M (2021) *bbs-Zahlenspiegel 2021: Daten und Fakten zur Baustoff-Steine-Erden-Industrie*, Berlin