CHALLENGES IN THE TRANSFORMATION OF PRODUCTION AREAS

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Abstract

Economic success is an essential component to the survival of private enterprises. Particularly in production areas, there are various, powerful opportunities to improve both the company's cost structure and sales. Driven by the ongoing need to adapt to changing market conditions, regular transformation processes in production areas are initiated. The challenge for the management is now to decide at what time, with which measures, to what extent and with what intensity to react to the changing conditions.

Key words: *designing of production areas, transformation requirements, short-cycle determination*

1. INTRODUCTION

Economic success is an essential component to the survival of private companies. It determines the enterprise's market position, but also its perception in society at large. The company's profit is a generally accepted measure of economic success, making both increasing revenues and minimizing costs key to companies across all business sectors in order to compete. Particularly in production, powerful levers are available to improve both the cost structure of the company (material, personnel and energy demand) and increase sales (quality product, delivery performance). Driven by the ongoing need to adapt to changing market conditions, regular transformation processes in production areas are initiated. The term "transformation" should be understood as the "remodeling" of production areas or the "adaptation" of production areas to changing conditions. The acquisition of a new production facility, the introduction of a new software, the initiation of continuous improvement processes, the setting up of a new production location, the relocation of production facilities, the launch of new products, the reorganization of an operating area, the chaining of plants and processes, or the networking of production plants, components and IT are examples of transformation projects in production areas.

2. THREE MAJOR TRENDS AFFECTING PRODUCTION AREAS

From a production area point of view, three significant trends (shown in figure 1) can be observed, suggesting an increase in demand for transformation.

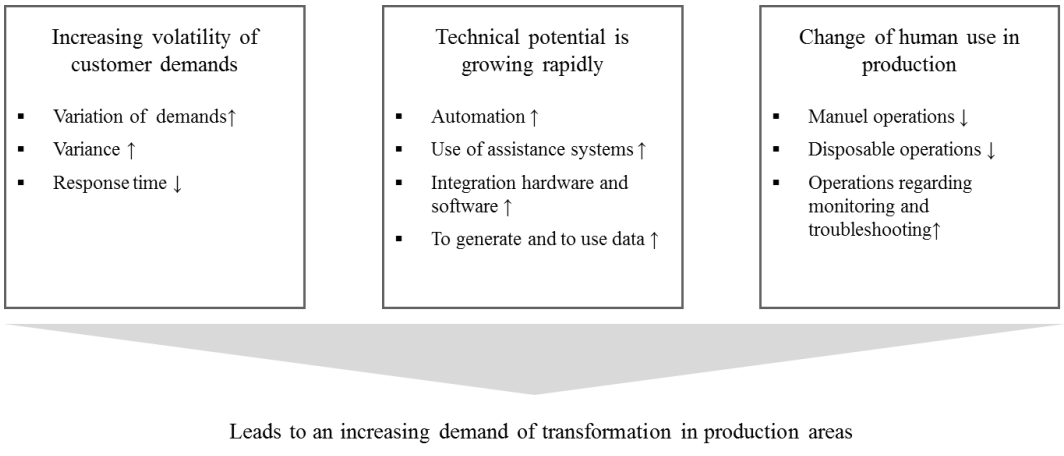


Fig. 1. Overview major trends affecting production areas

2.1. Increasing volatility of customer demands

Driven by increasing customer awareness of and sensitivity to price and quality, along with the rapid availability of raw materials, goods, and services across a globally-connected market, competitive pressure has increased across all value-add stages. The range of demands has become more various and response times are shorter than ever [1]. As a result, value chains are becoming ever-more fragmented. These developments lead to strongly fluctuating customer requirements, which lead to an increase in the complexity of planning, control and production.

2.2. Technical potential is growing rapidly

Technical progress offers new production solutions in ever-shorter time intervals. Beginning with the ongoing updating of existing plant and production technology, as well as software and communication solutions, the networking of hardware and software systems (cyber-physical systems and digital transformation) now follows [2]. This constellation leads to an increase in automated processes, the increased use of assistance systems, the increased networking of machines and IT systems, as well as an increased use of production and process data. The abovementioned increases apply to both the operation and the planning of production areas, for example, Building Information Modeling [3].

2.3. Change of human use in production

The presence of human beings in production is undergoing a sea change as well. Increasingly, simple and repetitive tasks are carried out by intelligent, networked machines. Human work is shifting towards the supervision and support of complex production facilities as well as trouble shooting [4].

In addition to the three trends mentioned above, which currently drive the change in production areas, other classic transformation drivers must also be mentioned [1]:

- Pressure on prices and costs due to heavy competition
- Pressure from the capital markets to achieve short-term positive results
- Laws, product regulations, processes, mobile and immobile equipment
- Local influences of the production sites

The challenge for management is now to decide when, with what measures, to what extent and with what intensity to react. Two fundamental aspects play a role in this decision-making process. One is the existing marginal conditions of the production area, for example, technologies, employee structure, company-specific handling of changes, qualification level, degree of automation, compensation systems, etc. [5]. The other is the strategic orientation and the specific target system (for example, productivity, quality, delivery reliability and stocks [6]) are included in the decision-making process.

3. STUDY

In a study carried out in 2016, the authors interviewed 35 production managers from 23 companies in southern Germany on their transformation requirements in production areas. Personal experience in the implementation and execution of projects served to answer the questionnaire. The following table shows the diverse attributes of the companies, plants and interviewed persons. Not all companies accepted publication of data and the results; therefore, the data is anonymous.

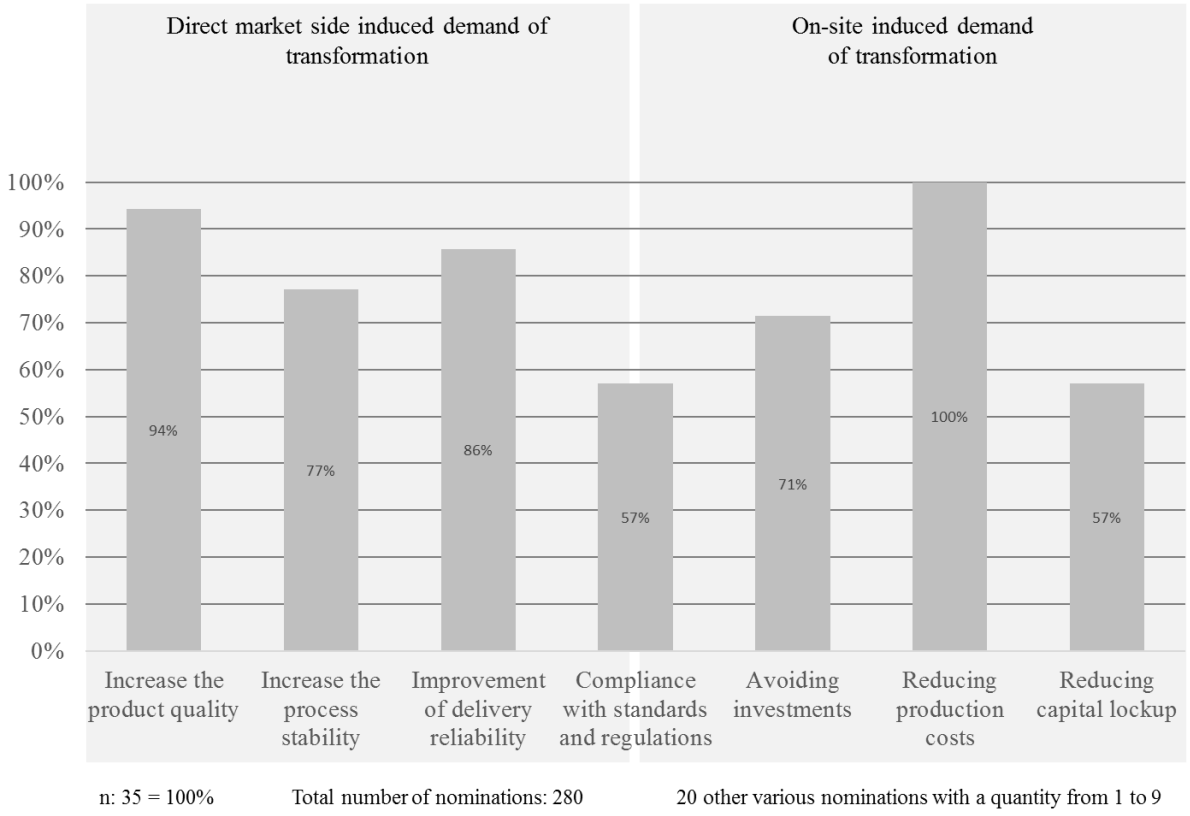
Table 1. Attributes of the interviewed persons and their companies

Number of Employees at the location	More than 1,000	250 to 1,000	Up to 250
	7	11	5
Industry sector	Automotive	Other	
	17	6	
Legal form	Stock company (AG)	Limited liability corporation (GmbH)	Private limited partnership (KG)
	6	14	3
Top Management	Owner-managed	Salaried Management	
	8	15	
Supply Chain	OEM	Tier-1	Tier-2
	2	16	5
Location of Production	Plants only in Southern Germany	Other Plants in Europe	Other Plants Overseas
	4	6	13
Status of interviewed manager	Head of Production (Global)	Head of Production (Plant)	Head of Production (Unit)
	6	13	16

When compared to the whole of Germany, the pool surveyed display a preference for large companies and business activities in the automotive sector. This is due to the fact that the main players in the German automotive industry for example Mercedes, BMW, Audi, Porsche and several tier one suppliers are headquartered in Southern Germany.

Figure 2 shows the result of the study. It shows that the two key objectives when initiating and implementing transformation projects are the reduction of production costs (100% of respondents) and the improvement of product quality (94% of respondents). In third place was improvement in delivery reliability (86% of respondents). According to the interviewees, external delivery reliability (to the customer) was in focus. Nevertheless, the majority of the respondents consider it useful to begin by gradually improving internal delivery performance (for example, in individual production and assembly areas). In this context, some managers stressed the central importance of introducing suitable measuring points. Fourth was the requirement to improve the stability of the processes by means of transformation in production areas (77% of respondents). In addition to manufacturing and assembly processes, the establishment of existing planning and control processes also play a role. Avoidance of investments is ranked fifth (71% of respondents). Particularly representatives of smaller companies spoke of strong budget limitations. In this case, continuous improvement was seen as a feasible solution to enabling major changes with minimal investment. However, in these cases, the necessary human-resource allocation and the necessary power of persuasion were usually higher. The reduction of capital commitment costs and compliance with standards and regulations came in next in the ranking (57% of respondents). The reduction of capital commitment costs has often been mentioned in conjunction with working capital management, but also relates to the reduction of stored finished products. The fulfillment of standards and regulations cannot be directly correlated with the direct market-side transformation needs or the company's transformation needs. Standards such as the quality management standard for the automotive industry (ISO TS 16949) or the group standards of automobile manufacturers have an impact, as do other general legal requirements such as certain safety-relevant regulations for products, machines and systems.

Fig. 2. Overview of named fields of requirements for transformations



Twenty other requirements, such as ergonomic improvements, the continuity of IT systems or the flexibility of production areas, also came up. However, their responses were less than 50 percent and can all be proscribed to other categories in figure 2.

Finally, all participants were questioned as to whether they use or know a standardized procedure for determining their transformation requirements. The overwhelming majority use specification sheets. Frequent triggers are capacity bottlenecks, quality problems or delivery difficulties.

4. CONCLUSION FROM THE STUDY

Though, in theory, the factors in figure 2 should represent the main drivers of transformation, in reality the need for transformation stems from the breakdown of existing technical infrastructure, rendering some areas of production useless. The triggers for the creation of such loadheads, mentioned above, can, in principle, be assigned to the described requirements ranges, but they are usually viewed individually, without a systematic background. In this context, initiated projects are reactive in nature, and do not allow for much freedom for strategic planning. Thus, the drivers described in figure 2 must be viewed as limited.

In order to ensure economic success, an approach is required that combines transformation requirements resulting from immediate conditions and long-term transformation possibilities.

5. RELATED THEORETICAL MODELS

The increasing dynamism of the manufacturing industry and the "turbulences" generated by this process generate numerous scientific works dealing with "transformability". Nyhuis, Reinhart and Abele published a study on the German market [7] under the title "Wandlungsfähige

Produktionssysteme". In this context, "transformability" is defined as the ability to reactively and proactively transform an infrastructure in organization and technology beyond existing flexibility limits [8]. As a result, the study identifies the need for research in the development and design of robust and standardized organizational and technological processes, a holistic transformation concept across the entire value chain as well as a method of assessment. The latter is necessary, since the budgeting of transformable structures is an obstacle to decision-making, since current production methods tend to be more cost-effective [7].

Westkämper describes "transformability" as the "speed of implementation of the transformation demand" and speaks in this context of the "ability to transform production companies" [1]. The “Stuttgarter Unternehmensmodell” was developed to describe and classify the manufacturing conversions in organization and technology caused by stemming from disruptions in company service provisions. The theoretical solution is based on the disciplines of business administration, production engineering, work sciences and company psychology as well as computer science. The “Stuttgarter Unternehmensmodell” proposes methods, tools and procedures for transformation, by taking into account management processes, the planning of structures and adaptive assembly and processing systems, the use of employee potential, the planning and control processes of changeable structures, and information systems and knowledge management [1]. The implementation of this approach is a challenge. In particular, real estate and equipment, which represent long-term commitments can now be regarded as structural limits for the conversion of production areas. The study "Turbulenz und Wandlungsfähigkeit", completed in 2003 in cooperation with the Institute for Industrial Production and Factory Operation (IFF) and the Fraunhofer Institute for Production Engineering (IPA), provides further evidence of the challenges of this approach, in particular the "fears of the employees regarding change", the "inadequate demand for change by the management" as well as the "conflicting company / employee targets".

A preliminary study commissioned by the German Federal Ministry of Education and Research dealt with changes in manufacturing [9]. Related to the requirements on transformability, the study, carried out by the Fraunhofer Institute for Industrial Engineering and Organization Stuttgart, the Chair for Economic and Industrial Sociology at the Dortmund University of Technology, and the Fraunhofer Institute for System and Innovation Research, Karlsruhe, shows the need for improvement in transfer and research in the areas of HR, inter-company cooperation and the introduction of a process-oriented organization. Examples for the identified deficits can be the mediation of company change by managers as well as communication difficulties.

In the joint research project "Wamopro", topics concerning change and the ability to transform were analyzed by modular production systems [10]. One of the results of the project was a guideline for the management of transformation processes. The core content was 1) a system for determining conversion requirements and, 2) a modular method for the conversion of business areas. Beginning with identification and analysis, a subsequent self-assessment of the existing conversion capacity and the creation of an early warning system, could be used to determine conversion requirements for the company. These and other advanced approaches to modularization and configuration have been tested in the industrial environment. As a result, it has become apparent that these approaches and methods can be used, but only with considerable individualized adjustments during initial application, which can result in heavy initial costs.

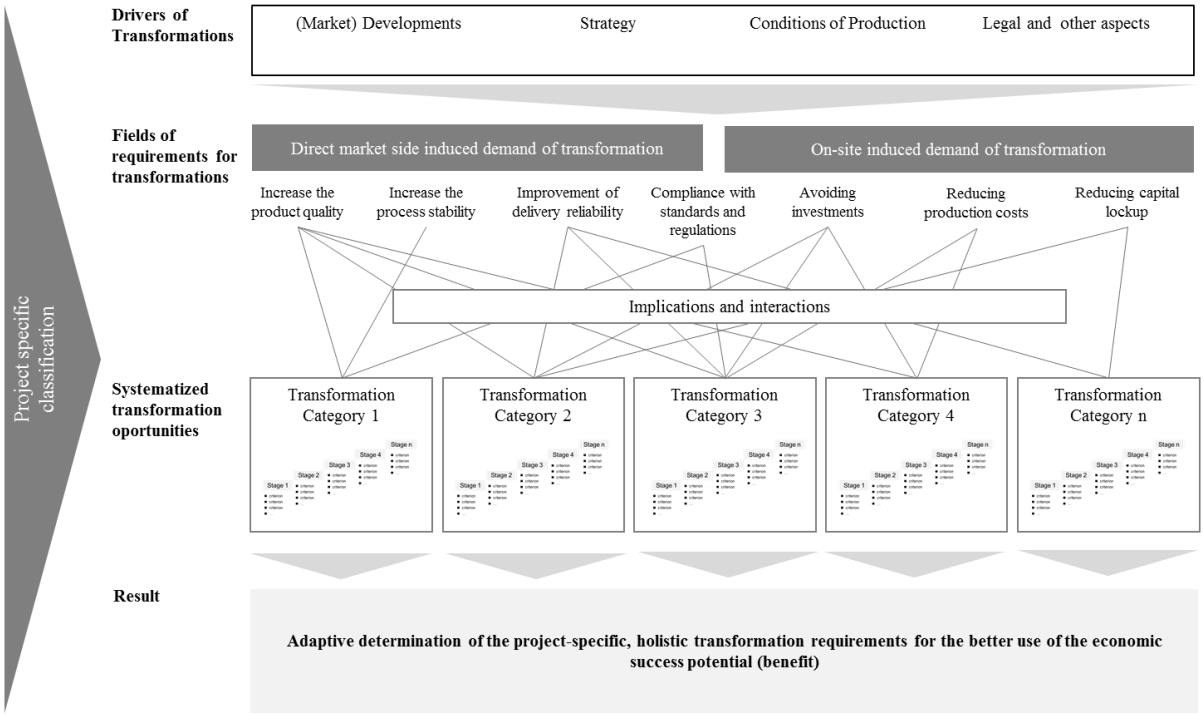
From these scientific approaches, it can be concluded that creating sweeping operational solutions is lengthy and has a number of obstacles, including the limitations of changeability, the handling of human fears, aspects of personnel management, lack of budgeting procedures and intensive effort. The authors conclude that the described scientific approaches are designed for long-term transformations of production areas. New solutions are needed that meet the short-term transformation requirements in operational practice while at the same time supporting the long-term transformation processes towards transformable structures.

6. SHORT-CYCLE APPROACH

In principle, transformations can be categorized as organizational, technological, procedural, infrastructural, digital or cultural changes.

Figure 3 shows an individually prioritized selection of transformations in their respective categories. This is intended for broad use in operational practice, which allows transformation requirements to be systematically transferred into options and to select suitable solutions. Ultimately, there is a strong link between the requirements and the possibilities that result. In order to better exploit the potential for economic success, practical and intuitive activities are to be supported in practice by the sketched systematic approach.

Fig. 3. Schematic representation of an adaptive approach for the determination of transformation requirements



7. CONCLUSION

The three trends observed from the productions' point of view, *increasing volatility of customer demands*, *rapid growth in technical potentials* and *the changing use of humans in production*, lead to a growing demand for transformation of production areas. According to a study conducted in 2016, in which managers of production areas in southern Germany were interviewed, the requirements for transformations in production areas can be divided into seven fields of requirements. However, the study also shows that in practice these transformation requirements do not approach transformation holistically. The advantages of such an approach lie in the more effective use of improvement potentials. The approach of the authors is therefore intended to contribute to the determination of transformation needs in a short-cycle and holistic manner.

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