

## **IDENTIFICATION AND ASSESSMENT OF NEED FOR CHANGE WITHIN PRODUCTION SYSTEMS**

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### **Abstract**

Manufacturing companies are forced to change at increasingly short intervals due to external market dynamics. In this context the changeability of production systems is a crucial factor of its viability. It describes the ability to undertake structural changes on all levels of a production system initialized by internal or external change drivers under the condition of minimal risk and effort on the one hand and maximal benefit on the other hand. The timely and thorough identification of change drivers is therefore a key success factor for competitive advantage. The paper presents a methodology which supports manufacturing companies to identify internal requirements for change based on external change drivers and helps to assess the benefit of different change scenarios. The presented methodology is part of a publicly funded research project build by an interdisciplinary research consortium in order to investigate the holistic socio-technical dimensions of the described problem.

**Key Words:** *Production, Changeability*

**JEL Classification:** *Organization of Production, Production Management*

## **1. Introduction**

Due to rapidly changing and difficult to predict environmental conditions the changeability of a production system has become a crucial characteristic in order to stay competitive (Westkämper, 2006:3). The increasing individualization and volatility of customer demand, shorter product life-cycles and greater competition through market globalization represent just a few of current change drivers. Changeability requires a fast adjustment of internal operational structures and processes and a reliable assessment of the risks and benefits that come along with such interventions (Wiendahl, 2007:2).

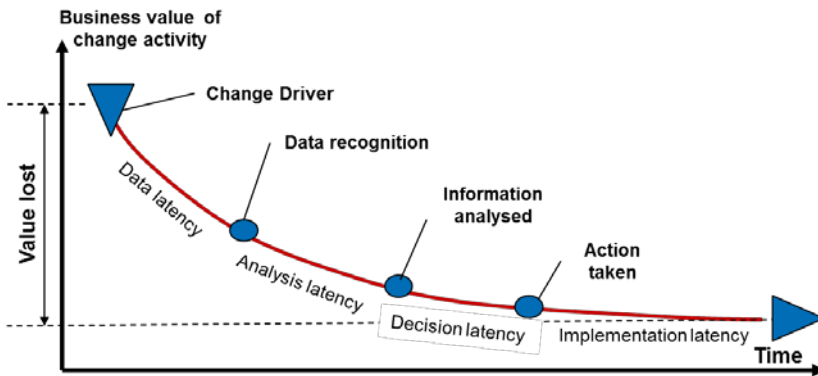
One key prerequisite for a changeable production system is therefore a systematic perception of relevant environmental events or trends, the fast deduction and identification of internal change levers as well as a reliable assessment of possible change scenarios. This paper presents a methodology that supports executives and employees of manufacturing companies in identifying external change drivers, uncovering affected areas of their production system as well as assessing reaction strategies

### **1.2 External and Internal Change Drivers**

Each individual organization is part of a subordinate economic system which can be divided into a general and a company-specific environment (Rüegg-Stürm, 2003:24ff). Whereas the general environment comprises broad macro-economical, ecological, social, legal and political issues, the company-specific environment consists of elements with a immediate influence on a company's performance that may – at least to some extent – actively be influenced by the company itself. Both environments contain potential sources of change drivers. Referring to WESTKÄMPER the most relevant ones can be assigned to the following categories: product variation, product life cycles, fluctuations in customer orders, logistics, technical progress as well as regulations and rules (Westkämper, 2009:10). Despite the enormous complexity of such change drivers, they affect a production system only via a limited number of channels. CISEK for instance reduces the amount of possible channels for manufacturing companies to the following: product or product variations, cost, time, quantity and quality (Cisek, 2002:441-445).

While a reactive change process is triggered by environmental changes that have already occurred, the aim of a proactive approach is to actually initiate change processes prior to the occurrence of an imposed need for change (Krüger, 2009:39). Reactive change processes are characterized by a significant time delay between the occurrence of a business relevant event and the final implementation of proper measures (fig.1).

Figure 1 – Latencies of change processes (zur Muehlen, 2009:11 )



In order to increase a companies changeability, methodologies are needed that help to reduce this latency between perceiving and recognizing the relevance and impact of change drivers and the final implementation of appropriate actions. The need for change has to be identified early and as comprehensively as possible.

So far, relevant approaches can be found within two subdomains of the strategic management: the Issue Management as well as the Risk- and Chance-Management (Michaeli, 2006:3). Both fields focus on the identification of external change drivers based on non-directional observation of weak environmental signals (“scanning and monitoring”) as well as the focused observation of key figures. However, a consequent deduction of specific internal need for change based on external signals as well as the identification of interdependencies between directly affected internal change drivers and other corporate modules is missed out. Besides external change drivers, derived directly from dynamics of the business environment, internal change drivers need to be considered as well. They result primarily from interactions in corporate

adaptation processes. Such processes are represented e.g. by technological changes like the introduction of a new welding process which in turn entail a change in the qualification requirements of the employees or adjusted fire protection measures.

Consequently, a holistic analysis considering the total need for change should not limit on external change drivers. Additionally it is essential to evaluate interdependencies between internal corporate change drivers and to developed potential change scenarios in order to attain an efficient handling of business relevant events.

## **2. Methodology to identify a companies demand for change**

The preceding considerations show that a methodological support of the perception and recognition phase of a change process can accelerate the timespan between the occurrence of a change driver and the initiation of appropriate actions. Hence, such a methodology may significantly increase a firms changeability.

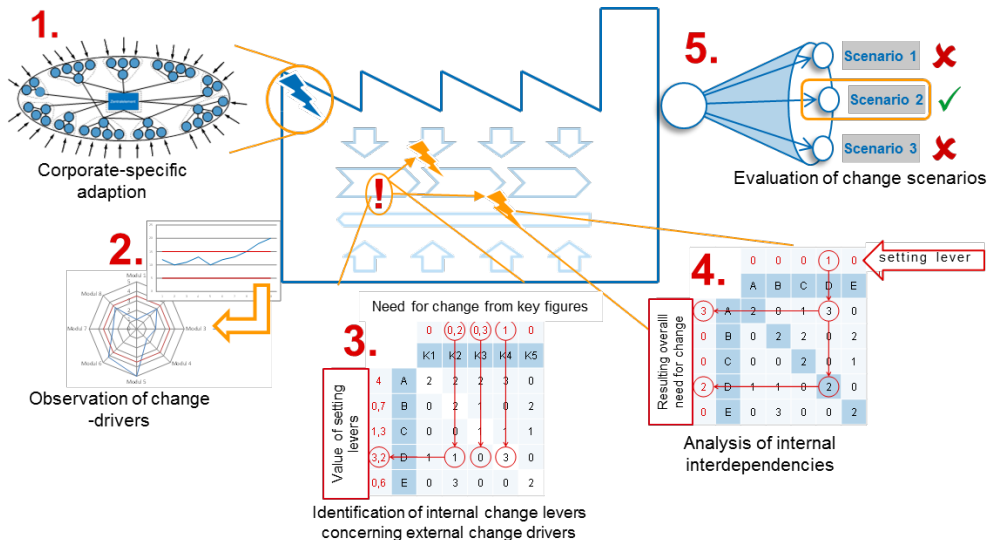
A fundamental requirement of such a methodology is the possibility of a quantitative detection and description of both external and internal change drivers and their influences on the various areas of a production system. Technological as well as socio-technical aspects of a production system have to be integrated into a holistic approach. In order to fulfill these requirements, the following eleven areas were defined as modules of a changeable production system: employees, organizational structure, process organization, communication and information, management and culture, buildings, infrastructure, product as well as technology.

The methodology for the identification of an externally and internally caused need for change and the assessment of change scenarios is divided into the following five main steps (fig. 2):

1. Company-specific adaptation of the Changeable Production System (CPS) Key-Figure-Catalogue
2. Detection and monitoring of key figures in order to identify external change drivers (primary need for change)

3. Identification of internal change levers in order to react to the external need for change
4. Determination of the total need for change (secondary need for change) and deduction of change scenarios under consideration of internal change drivers and dependencies
5. Assessment and selection of change scenarios

Figure 2 - Main steps of the CPS-Methodology



### 2.1. Structure and adaptation of the CPS Key-Figure-Catalogue

The fundament of the CPS Key-Figure-Catalogue is based on a comprehensive analysis of industrial change drives which were evaluated through literature analysis and interviews with executives from companies within the research consortium as well as other industry partners. In a first step generic external change drivers were derived based on a traditional industry structure analysis. In accordance with PORTER (Porter, 1980) five general industry forces were considered here: the negotiation power of clients and suppliers, the threat caused by substitute products or services and the rivalry between new and established

competitors. In addition, complementary products and services that could have a positive impact on ones own business performance were taken into account as potential sources for a demand for change (Simon, 2000:243). 25 aggregated key factors were identified, allocated with measurable and linked with the corporate modules. This systematic projection of the industrial forces respectively the external change drivers on company specific modules states the first step of the methodology. It specifies the above mentioned channels through which change drivers of the a company's environment impact on a company and therefore reduces the management complexity of environmental developments.

## **2.2. Identification of externally related demand for change**

A systematic deduction of change demand needs to be integrated into organizational and procedural structures of a firm. Therefore, roles, communication routines and responsibilities should be defined. Since small and medium sized companies often can not afford explicit experts, the identification processes and tasks should be implemented within the existing staff. Further, a basic requirement for a reliable identification process is the definition of company-specific target corridors as well as alert and action thresholds concerning the specified key figures. Relevant data sources should be selected within step one of the methodology. In contrast to strong, quantitative signals (e.g. consumer demand), which can be monitored easily, weak qualitative signals need to be transformed and channeled into the company. The evaluation of such signals can be supported by standardized trend announcements templates. Such templates can be used to review and evaluate the employees perception concerning possibly relevant change signals in a standardized and focused way.

## **2.3. Alignment with corporate levers**

Once an externally caused need for change has been detected it has to be matched with potential corporate levers. Such levers are elements of a company which can be modified in order to actively respond to a specific undesirable situation. A matrix that maps the causal connections between change drivers and adaptable elements of a production system has been developed in order to identify possible corporate levers quickly (fig 3). All corporate modules are linked with more detailed information about their real characteristics so that further

analysis can be undertaken in order to get a transparent view of the complete impact of the change driver into the production system.

**Figure 3 - Alignment of change drivers with corporate modules**

		external change drivers												
		A	B	C	D	E	F	G	H	I	J	K	L	M
enterprise module	Staff	2	1	1	2	2	1	3	3	2	2	2	1	1
	Organisational structure	2	1	0	1	2	1	2	2	2	1	1	1	0
	Operational structure	2	2	1	1	2	1	2	1	2	2	1	0	0
	Building	1	1	1	1	1	1	1	1	2	2	1	2	1
	Infrastructure	2	1	2	1	2	1	1	1	1	1	2	2	1
	Technology and production facilities	3	1	2	2	2	2	2	2	2	3	3	1	1
	Product	3	2	3	3	3	3	1	1	2	3	3	1	1
	Information and Communication	1	2	1	2	2	1	2	2	2	2	2	1	1
	Management and enterprise culture	2	1	1	1	2	1	2	2	2	2	2	1	1

External change driver	
A	Market development
B	Delivery reliability of supplier
C	Price development of primary materials
D	Product quality of supplier
E	Market share
F	Price development of competing product
G	Regional demographic structure

## 2.4 Determining the overall demand for change

After the external change drivers have been identified and channeled onto the corporate modules, the primary need for change is specified. In a further step the overall or secondary need for change has to be specified by investigating the interdependencies between the modules. An interdependency matrix serves as a support to depict the degree of interdependencies between the modules concerning the identified demand for change. Looking at a specific element (e.g. operating resources) the entries of the matrix specify which other elements (e.g. employees, infrastructure) need to be transformed as well in order to enable a successful change of the primarily affected module. The strength of the interactions is thereby evaluated using a classification from 0 (no dependence) to 3 (strong dependence). Experts who are assigned to the adaptation must have both sufficient enterprise and appropriate module content expertise. In order to avoid double-assessments, which can distort the analysis, only direct effects on other elements are to be considered. It is therefore advisable to create the matrix line by line (Vester, 2002:343).

This described procedure helps to derive a consistent picture of the overall need for change and gives valuable hints for the elaboration of possible change scenarios.

## **2.5 Assessment of possible change scenarios**

The assessment of the developed change scenarios has to consider corresponding quantitative as well as their qualitative benefits and efforts for each scenario. Depending on the kind of change scenario qualitative and quantitative aspects can be distributed quite dissimilarly. In order to cover both criteria comprehensively, the methodology combines a classical utility analysis with a risk-specific net present value method (Heger, 2007:111). Qualitative aspects are assessed with a utility analysis. For this purpose operative and strategic corporate goals have to be captured and weighted against each other, which is done by pairwise comparison. In order to provide the user with a generally valid operative goal catalogue, the logistic indicators for production according to VDI 4400 norm have been integrated into the method. In a second step it has to be assessed in how far the competing change scenarios fulfill each corporate goal. The aggregated fulfillment values represent the qualitative utility value of a scenario. All aspects that can be quantified monetarily are assessed with a risk-specific net present value method. Prerequisite is a comprehensive estimation of earnings and costs associated with each change scenario. In this step different developments of external change drivers are taken into account and linked with probability values in order to evaluate the risk or bandwidth of net present values associated with an investment in change activities. Finally the identified need for change has been transformed into quantitatively evaluated change scenarios that state the input for into further decision processes.

## **3. CONCLUSION**

Companies are facing high market dynamics which lead to constantly changing requirements on their service provision. Therefore changeability is an important success factor. Particularly the early stages of a change process are characterized by a lack of methodological support.



In conjunction with the knowledge and experience of a company's staff the presented methodology supports the change process, especially during the perception and recognition phase. To identify a need for change, both external and internal change drivers are considered.

Despite the presented methodology, the decision to change and the definition of promising change measures remain to the employee in the company and still represent sophisticated and highly complex management tasks.

However, by using the methodology the identification of need for change can be accelerated significantly. The representation of internal interactions also increases transparency with regard to possible effects of change measures on other divisions of the company.

To identify need for change one should be aware that not all change drivers can be displayed in the form of figures. Also changes in a company's environment, which cannot be determined quantitatively, can force a company to change, e.g. a changing legal provision or a change of a standard.

#### **4. Acknowledgement**

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