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A Game-based Approach to Understand Human Factors in Supply Chains and Quality Management

Sebastian Stiller[a]*, Björn Falk[a], Ralf Philipsen[b], Philipp Brauner[b], Robert Schmitt[a], Martina Ziefle[b]

[a] *Laboratory of Machine Tools and Production Engineering (WZL), RWTH Aachen University, Germany*
[b] *Human-Computer Interaction Center, RWTH Aachen University, Germany*

* Corresponding author. Tel.: +49 (0)-241-80-20716; fax: +49 (0)-241-80-22671. *E-mail address:* s.stiller@wzl.rwth-aachen.de

Abstract

Quality management is an important function for viable production networks. In order to qualify decision makers to understand the fundamental principles of quality management in production networks, a game-based simulation and learning environment is developed, which can furthermore be used to understand how human factors influence the quality of decisions in complex production networks. Previous studies have shown that underlying factors must exist, which predict the players' performance. It is currently unexplored, which factors are contributing to high performance. To deeper investigate which human factors are critical for supply chain success and to further refine the quality management game a series of studies were examined. As expected, expertise had a great impact on performance, however contrary to the expectations cognitive skills had none. The refined decision dashboard, with seamlessly integrated self-adapting visualizations on key performance indicators, had a significant positive impact on game performance. The studies suggest that the developed game is a valuable contribution for the qualification of quality managers, as the quality of decision increased.

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1. Quality management in production networks

Quality management is an interdisciplinary function in industries and organizations. It aims at controlling the complex interplay of heterogeneous processes in a highly dynamic environment. That is, quality management gives a contribution to the decision making process on all entrepreneurial levels from the macroscopic perspective of production networks and supply chains down to the shop floor level, where product and process parameters have to be controlled and adapted in order to maintain stability and capability [1]. Ever since the foundation and successful establishment of the total quality management principle, quality management was directly connected to entrepreneurial success [2]. Hence, quality management offers methods, solutions and tools to support decision making processes in many different functions and fields.

Quality management units are typically in lead, or process owner for several entrepreneurial processes [3]:

1. Quality politics and strategy planning
2. Coordination of quality management methods
3. Standardization of documentation
4. Continuous improvement processes
5. Quality and inspection planning
6. Quality control and assurance
7. Supplier assessment and development
8. Corrective action, change, complaint and defect processes
9. Auditing
10. Surveying customer satisfaction

While all these quality management processes are playing an important role throughout the organization, the processes four to ten can have a direct impact on the value stream; they are not only management or supporting processes, but are

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directly connected to the customer, or the value stream. Hence, quality management eventually has a significant interface to the work and tasks of other entrepreneurial management disciplines in the value stream such as production, logistics and supply chain management and purchasing.

2. Analyzing the interfaces of quality management with direct functions

In order to understand the interface between the management disciplines in supply chains and quality management, the methods and target systems of these disciplines were analyzed and reviewed. Logistics, purchasing and supply chain management are not strictly differentiated in literature. Therefore a process oriented approach was selected, defining the main tasks of these functions which are directly connected to the management of the value stream of production networks:

- Supply chain design
- Demand planning
- Planning of procurement and purchase
- Inventory control and management
- Supply Chain and production planning and control (PPC)

2.1.1. Quality management and supply chain design

Supply chain design covers all tasks connected from the identification via contracting over to the phase-out of suppliers [4] [5]. In order to identify suppliers and possible locations for the production networks various qualitative and quantitative decision methodologies and algorithms especially from operations research can be used. These methods are considering various factors (e.g. price, distance, place, company size), which have to be considered when decisions about the supply chain design are made [5]. Quality management is giving different contributions to these decision factors. Within the process of supplier development and auditing, quality management has the task to assess the system, product and process quality level of suppliers and negotiate quality assurance agreements between the producer and its suppliers. Moreover, quality managers are in charge to run complaint processes to the suppliers using 8D-reports as the state-of the-art methodology [6].

2.1.2. Quality management and demand planning

The demand planning process uses several forecasting methods in order to predict the customer demand for the supply chain. Based on these demands the capacity of the production plants is planned [5]. Especially the processes of quality management which are directly connected to the customer, such as complaint, claim and call-back management are processes which have a significant influence on customer satisfaction and eventually on sales volume [6].

2.1.3. Quality management and procurement planning

Methods such as the ABC/ XYZ analysis are the basis for the decision about the sourcing policy of supply chain management [4] [5]. Sourcing policies are differentiated by the trigger point of the sourcing (reorder-point vs. frequency) and the elaboration of the order quantity (order-up-to-level vs. economic order quantity). Nevertheless modern sourcing policies have to consider the inspection policy and the supplier quality level: A just-in-time delivery with the parts shipped to line would be fatal, if the supplier had issues in process or product quality [5].

2.1.4. Quality management and inventory control

The task of inventory control is to define the necessary level of stock in order to reach the desired service level, while inventory costs should be minimized [4] [5]. Depending on the quality level of production processes and the scrap rate, quality management is giving an important input to the inventory planning process. On shop floor level, quality and inventory control have to establish concepts which guarantee that defect parts, or parts for rework or scrap are not confused with work-in-progress inventory.

2.1.5. Quality management and production planning and control

The Aachen PPC model is a well known regulation framework for the tasks and processes of production management [7]. Quality management processes such as inspection planning, quality control and assurance, and continuous improvement have a significant interdependency with these production management processes. Based on the quality and inspection planning, inspection control work places are designed and integrated in the value stream of the shop floor. Faulty parts and disturbances of machines can cause severe changes and potential turbulences within the production program. Moreover quality management contributes various optimization methods such as the Design-of-Experiments (DoE) for effectiveness and efficiency of machines and processes on shop floor [6].

2.2. Challenges for the integration of the tasks

Nowadays the analyzed interfaces are often implemented in production IT-systems, which support the work flows and decision makers. These systems have a modular structure, meaning that the described processes can be decoupled from each other. To give an example: The purchasing and ordering function of an ERP system does not necessary exchange information with the CAQ or MES module about current scrap and failure rates within the production, but sets the fraction of faulty parts as a constant variable in the system. According to expert interviews, the integration of the methods and interfaces in theory and IT-system can bring a significant benefit for production companies but might also increase the complexity for decision makers in quality, production, logistics and supply chain management. Hence, cause-and-effect chains which were primarily taught within the IT-