Approaches to Improve Shop Floor Management

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Abstract. The task of shop floor management is to ensure high effectiveness and efficiency of a production system. The objective of this paper is to identify potentials for improvement of shop floor management in the context of digitalization and to identify fields of action. As a result, the paper shows four categories of deficits in shop floor management, respectively information management. First, insufficiently designed business processes lead to additional administrative work for shop floor managers. Second, shop floor management can be strengthened by improving e-mail communication. Third, the meeting organization and fourth, the reporting offer potential for improvement. The creation of reports and the preparation of key figures, for example, involve routine activities that do not add value and can be partially automated. Therefore, as part of the project, a shop floor board was prototypically developed using a low-code development platform in order to demonstrate the potential of this approach.

Keywords: Shop floor management · Low-code development platform · Shop floor board

1 Introduction

Shop floor management is an integral part of a production system [1]. The task of shop floor management is to ensure high effectiveness and efficiency of a production system. Managers must actively lead as mentors and problem solving coaches [2]. Therefore, they have to be present at the place of value creation – and not primarily in the office [3]. Analyzing problems by practicing daily meetings and routines at the place of value creation lead to a more intensive exchange of information [2]. In addition, numerous further rules for Lean Leadership can be found in literature [4].

Increasing complexity in production – in particular due to shortened cycles of innovation and growing diversity in product variants – results in increasing demands for information management in production [5]. This creates new challenges for managers. They must coordinate a large number of different tasks [6]. Managers have to react flexibly to the changing framework conditions surrounding leadership and the use of new software systems in the company.

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One goal of the project Arbeit4.0 - AWARE is to improve the work of managers on the shop floor. To do so, it aims to identify routine administrative tasks that can be reduced or eliminated through digital support, leaving more time for real management tasks. In addition, it works to pinpoint deficits in information delivery, in order to derive recommendations for action to improve information management. To achieve the project's goal, semi-standardized, problem-focused interviews were held with managers from production at an international company in the capital goods industry. Section 2 describes the method, Sect. 3 the results of data collection and evaluation in summary. Details can be found in a previous publication [7]. For one identified field of action, a solution approach was prototypically implemented in a case study. The presentation of the developed prototype is subject of Sect. 4. Finally, the paper provides a brief discussion (Sect. 5).

2 Method of Data Collection and Evaluation

A process consisting of five steps has been selected to identify fields of action for improving shop floor management. These steps are the following:

1. Determination of the interview objectives
2. Creation of the interview guideline
3. Execution and transcription of the interviews
4. Evaluation through a qualitative content analysis
5. Appraisal of the results of the qualitative content analysis

One interview objective was the identification of administrative tasks that can be reduced or eliminated through digital support, leaving more time for real management tasks. Another was the identification of deficits in information delivery and deriving recommended actions for these. Using the critical incident technique, a questionnaire was developed to implement a problem-centered interview as a survey instrument. Ten interviews were conducted with managers at an international company in the capital goods industry. The interviews were carried out in a partially standardized manner, in order to ask follow-up questions tailored to the respondents' answers and react flexibly to their responses. Two persons wrote down answers to the questions, which were then transcribed digitally. Evaluation of the interviews was carried out using qualitative content analysis according to Mayring [8]. During a workshop, the results of the qualitative content analysis from the interviews were presented to selected managers, in order to identify potential errors in interpreting interview results and to analyze the identified fields of action.

3 Results

The selected method and procedure of data collection and evaluation (Sect. 2) provided that there is no uniform understanding of real management tasks, since the question on what real management tasks are resulted in very different answers. For example, only four respondents named developing the skills of employees as a real management task.

In contrast, the ability to teach is considered one of the most important requirements for managers in literature [9].

There is a discrepancy between management tasks perceived to be time-consuming and tasks perceived to be important by respondents. In the opinion of the respondents, the greatest amount of time is not spent on the most important tasks. For example, five respondents viewed preparing key figures as the most time-consuming task, while seven respondents felt interacting with employees was the most important task [7]. In addition, qualitative content analysis was used to identify deficits in shop floor management, respectively information management. Four categories of deficits were identified [7] (see Fig. 1).

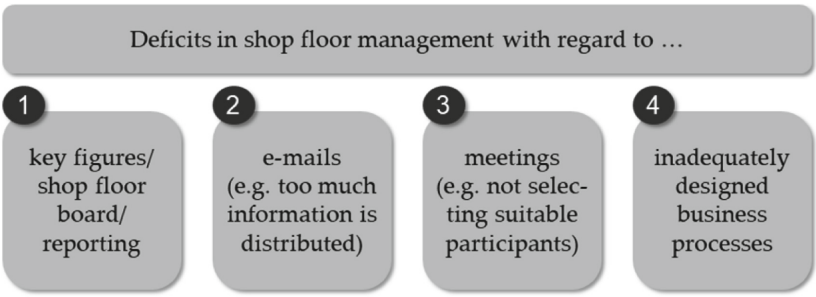

Fig. 1. Categories of deficits in shop floor management

Deficits in preparing key figures include manually entering data and manually linking information from various IT systems, which can often result in errors. Concerning e-mail correspondence, one negative aspect described was that too much information is distributed in e-mails to too many recipients, without prioritizing the topics included. This results in long searches through e-mails for useful information. Causes of failing to design meetings in a targeted way were described in not selecting suitable participants for meetings and a lack of documentation of important meeting results. Several internal corporate processes were outlined as inadequate, resulting in managers having to handle administrative tasks and a failure to tap into potential areas of optimization. One example is the lack of a Manufacturing Execution System (MES).

4 Case Study – Designing an App for Preparing Key Figures

The results described in Sect. 3 were presented to stakeholders at a workshop. As a result, it was determined to prioritize field of action 1 (preparing key figures for the shop floor board and for reporting) in the further course of the project. In this context, the following requirements for a digital shop floor board should be included:

1. Simplicity of configuration
2. Information output via mobile devices
3. High usability and provision of information according to demands
4. Integration of a push function for automatic event information
5. Consideration of interfaces to other relevant software systems
6. Use of up-to-date key figures
7. Avoidance of administrative routine activities and errors due to manual data input (see Sects. 1 and 3).

With the aim of meeting these requirements as completely as possible, a prototypical solution was developed in the Industrial Engineering Laboratory of the Ostwestfalen-Lippe University of Applied Sciences and Arts. As a result, the shop floor board was implemented using low-code programming. Low-code means that only a marginal amount of programming code is required to develop software [10]. The design of an application (app) is done via so-called low-code development platforms. Such platforms use visual, declarative techniques instead of classical programming via codes [11]. Low-code programming is a model-driven software development approach with visual programming and automatic code generation. The advantage of this type of software development is that the qualification effort for using a low-code development platform is comparatively low. Ideally, the future user can develop his software by himself.

An assembly assistance system software was chosen as the application scenario for the development of the shop floor board. In the assembly process, the software records various status data (actual values) and stores them in spreadsheet files. Together with predefined target values, which are also stored in spreadsheet files, these form the database for the prototype of the digital shop floor board. In this, important key figures for the shop floor are prepared by comparing the target and actual values.

The software prototype was created with PowerApps, a low-code development platform (requirement 1) from Microsoft. PowerApps supports information output via mobile devices such as smartphones or tablets (requirement 2). The software is displayed as an app on the respective device via an icon and can be activated and controlled with multi-touch gestures. In addition, the utilized low-code development platform enables the use of a cloud service. All data relevant to the software can be stored in the corresponding cloud. This makes it possible to use the software wherever there is an internet connection.

The shop floor board (named as assembly KPI cockpit) developed for the described use case contains three main key figures: quantity produced, first pass yield and assembly time. The three key figures are presented graphically in a main view (see Fig. 2).

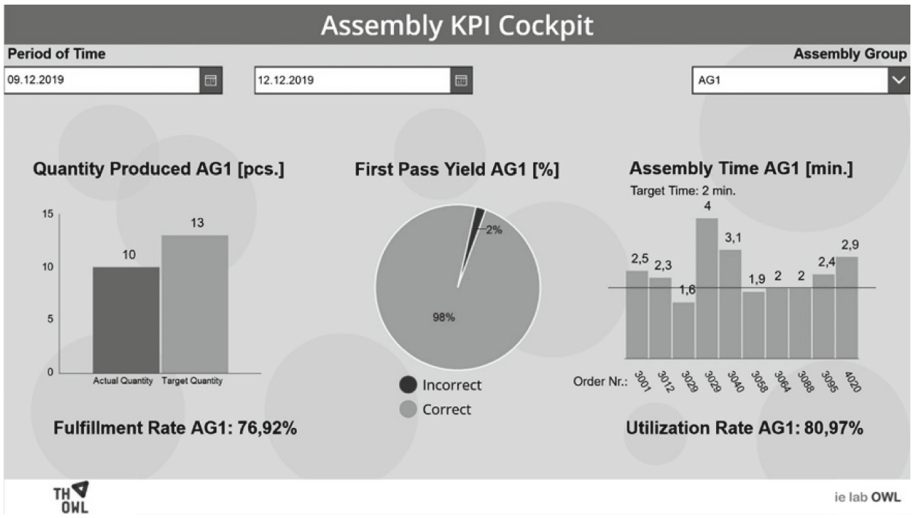

Fig. 2. Shop floor board developed via low-code programming

The key figure "quantity produced" is displayed in a bar chart by comparing the target quantity with the actual quantity of produced assembly groups. The fulfillment rate is the quotient of actual and target quantity. These figures allow deviations and their extent to be recognized at a glance. The key figure "first pass yield" is visualized in a circular chart in which produced assembly groups are divided into "correct" and "incorrect". With a view to this key figure, the respective proportion of correctly and incorrectly assembled orders for an assembly group can first be identified. By touching the circular chart, the incorrectly assembled orders are listed in a detailed view with indication of the error code. The information on the errors derives from the assembly assistance system software described, which stores the errors in a spreadsheet file after they have been entered by the user. For the representation of the key figure "assembly time", the actual times for the assembly of orders are shown in a bar chart. The target time for an assembly is visualized via a line through the bars, so that deviations (also in the course of time) can be identified. In addition, the target order times are set in relation to the actual order times to display the utilization rate.

If individual action limits are exceeded or undercut, this can be easily detected (requirement 3). In addition, the principles of dialogue design [12] are taken into account in the software displaying all essential information to the user (task adequacy). Controllability and customizability are considered by using buttons to output detailed information or filter functions if required. Consequently, for an output of the key figures the time period and the assemblies must always be selected.

If required, a push function (e.g. sending an e-mail) can also be implemented using PowerApps (requirement 4). Interfaces to other software systems can be implemented indirectly via exchange formats (e.g. via Microsoft Excel) (requirement 5). A data exchange via xml-files could not be realized as this format is apparently not yet supported. Interfaces to other software systems and the central administration of all data in the cloud ensure that the display of key figures is always up-to-date (requirement 6).

In summary, it can be assumed that the development of a digital shop floor board using a low-code development platform can sustainably improve the effectiveness and efficiency of the information preparation process (requirement 7), since recurring processes of manual data input and preparation are avoided. Ideally, the key figures are available in the way the users need them. Experience with the chosen low-code development platform has shown that it is suitable for meeting all essential requirements with little effort compared to classical programming.

5 Discussion

The interview results show that there is no uniform understanding of real management tasks among the respondents. In addition, differences can be observed between the tasks described in literature and the tasks performed by managers in operational practice. For example, managers in production carry out administrative tasks because individual business processes are not designed to meet requirements or the creation of reports is not automated. Moreover, it became clear in the interviews with the managers surveyed that there is a discrepancy between the tasks perceived as time-consuming and those perceived as important. For example, five respondents regarded the preparation of key figures as the most time-consuming activity, while seven perceived interaction with employees as the most important activity. The share of administrative activities must be significantly reduced in order to lay the foundations for shop floor managers being able to take care of their core tasks as described in literature. The reduction of administrative activities can be achieved through (partial) automation of individual processes. A low-code development platform can be used for this purpose. With the help of a case study, it could be shown that the low-code programming of an application can be carried out in line with requirements and with comparatively little effort. In a further step, this solution will be transferred to operational practice and be tested. In case this application proves itself in practice, further administrative activities should be eliminated by corresponding software solutions. At the same time, managers should be trained to use the time they no longer spend on administrative activities for real management activities.

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