The Renaissance of Industrial Engineering Presented in the Example of the Competencies for Time Data Determination

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Abstract

Approaches to increase productivity systematically, such as work measurement, require time data management (TDM) as an essential fundament. In these days many manufacturing companies are facing the challenge to rebuild or establish industrial engineering competencies and therefore also competencies in TDM. The central role of the management control over its strategic and operative planning and decision making business criteria is assigned to the manufacturing company's TDM. Based on a literature review an approach to develop a structure to specify relevant attributes describing the required competencies for TDM in the example of time determination is presented.

Keywords

Industrial Engineering, Time Data Management, Competencies in Time Determination

1 INTRODUCTION

Organisations involved in manufacturing are facing rising complexity in their inside and outside operations as well as increasing domestic and international competition. Hence, the demands on employees and managers are permanently growing. Consequentially, the necessary qualifications and competencies of an industrial engineer change. In fact, a profound knowledge of systemic interrelations and the ability to solve problems by methodical approaches in complex production processes are needed.

The central role of the management control over its strategic and operative planning and decision making business criteria is assigned to the manufacturing company's time data management (TDM). Whereas time data in particular is an important basis for a lot of relevant information to manage a company [1-4], the establishment and the operation of a TDM is manifold assessed as (excessive) time- and cost-consuming. As a consequence many companies refrain from operating industrial engineering and TDM-related functions and are therefore manufacturing respectively producing goods without a valid data fundament for planning, control and decision-making. Therefore a lack of industrial engineering and in particular time related competences can be stated in manufacturing companies.

2 INDUSTRIAL ENGINEERING

According to the Institute of Industrial Engineers “industrial engineering is concerned with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialized knowledge and skills in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design, to specify, predict and evaluate the results to be obtained from such systems” [5]. Industrial engineering leads the continuous improvement process and provides the system, methods and problem solving competences as well as additionally required key competences [6] (see Figure 1).

In this terminology competence implies that individuals are able to apply their traits, skills and knowledge in combination with experiences, values and norms in a self-organized fashion to novel situations successfully [7]. To enable an industrial engineer to act proficiently requires next to the technical competences additional social key competences as the independent and active participation in task forces, critical introspection and self-reflexion as well as the communication skills in order to work effectively in teams. This is especially important for industrial engineers who are organized in a staff-unit and work temporary as consultants with line-managers [8].

In industrial engineering the term system competence depicts the comprehensive of overall flow and individual performance on a systems level, in order to guarantee a goal-oriented alignment and prioritization of activities. In other words, industrial engineering connects the close to reality depiction of integral processes in production with the capturing and evaluation of dispersions, i.e. in manufacturing or logistics processes and derives conclusive fields of actions. Further, it derives goals and the process goals statuses from the superordinate objectives (strategic objectives, customer goals, factory goals, etc.) of the enterprise.

Hereby in TDM’s focus a systematic view on all processes of TDM is fundamental to understand the internal correlations within TDM processes and external connections to other management processes.

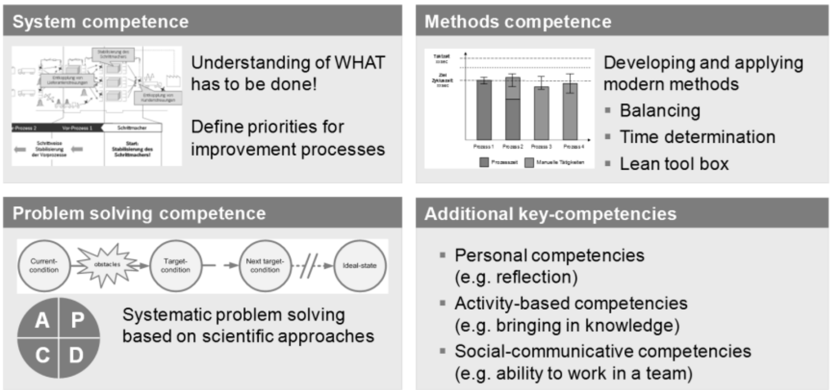

Figure 1 - Industrial engineering competencies [6, 7, 9, 10].

Methods competence in industrial engineering spans the ability to apply work measurement methods, balancing and lean methods for the definition of target states and standards as well as for the deriving ergonomically relevant data In TDM a profound knowledge about the application of different time determination methods and tools for different determination rates is as important as being able to apply e.g. the right levels of time categories and to develop process building blocks.

Problem solving competence in industrial engineering provides the necessary abilities for the goal oriented problem solving and hence the realization of a systematic and continuous improvement process on the basis of a PDCA-cycle. Industrial engineering creates the basis to move from a "current-state" to a "target-state" by means of a continuous improvement process. Here TDM contributes by providing actual current times and standard data e.g. to measure achieved time improvements during a PDCA-cycle.

The additional key-competences of industrial engineering encompass personal, activity and action-related as well as social-communicative competences, which enable a professional appearance and operation. Experience to distribute time determination knowledge and the ability to act self-organized in a group, e.g. in continuous improvement groups or with the works council are TDM-related competencies.

A lot of these competencies, methods and approaches required in modern industrial engineering are existing since a long period of time and are gaining high relevance again.

3 RENAISSANCE OF INDUSTRIAL ENGINEERING

The dissemination of the Toyota Production System in different industries started 1990, when MIT's survey „The machine that changed the world" was published [11]. Since then management approaches, principles and methods such as Total Quality Management , Lean Thinking, Factory Physics, Six Sigma amongst others are determining attempts to increase productivity causing a so-called "Renaissance of Industrial Engineering" [9, 12, 13, 14]. Industrial engineering regained high relevance due to these developments. Thereby a lot of these "new" approaches and methods are based on already established methods and principles from Taylor's times.

Therefore industrial engineers are facing new challenges such as methodical planning, designing and continuously improving of processes, application of production systems and new leadership issues. The current ifaa-Trendbarometer [15] also reflects these challenges (see Figure 2).

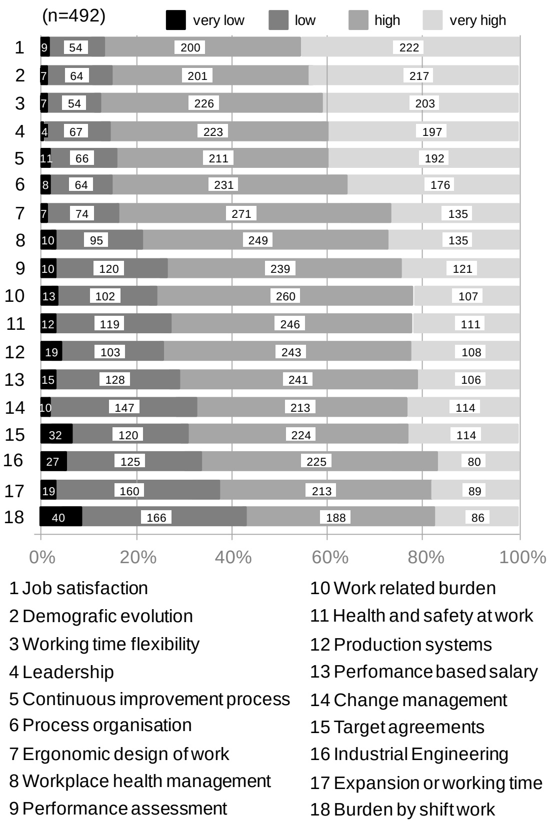

Figure 2 - Ifaa-Trendbarometer: survey july 2012.

It gathers the importance of actual topics in the field of human engineering, work organisation and industrial engineering. Classical tasks in work measurement (e.g. performance assessment and performance based remuneration) are therefore equally relevant as approaches and concepts to increase productivity systematically. Both require time data as an essential decision-making fundament.

Especially the topics “process improvement” and “process organisation” show high relevance for a longer period of time. Traditionally industrial engineering possesses competencies (e.g. work measurement and TDM) which are highly relevant for systematic and methodical improvement. Today industrial engineering is facing the challenge to pool, to adopt and to develop its competencies in order to lead and to accompany an immersive improvement process or systematic improvement of productivity. After a phase of downsizing industrial engineering structures in companies and therefore a loss of industrial engineering competencies a (slow) turnaround is taking place and a (re-) development of knowledge and competencies in industrial engineering is setting in [13].

During the last 10 to 15 years especially manufacturing companies but also non-profit organisations and science recognised the significance of industrial engineering as planning, control and decision-making factor again. Equally the consequences of wrong decisions taken on basis of incorrect or missing time data became obvious. In these days many companies are facing the challenge to rebuild or establish industrial engineering competencies – and in particular TDM competencies – again. In order to develop system competence in TDM a systemic view on all relevant aspects and processes of TDM is fundamental.

4 TIME DATA MANAGEMENT

TDM is summarised as all activities to manage the factor “time” [16]. Thereby TDM can be subdivided in time data determination, pre-processing and application [17]. Time data determination covers all functions and responsibilities to specify time data. The analysis, composition, representation and application-oriented preparation are summarised in time data pre-processing and administration. This implies that also time data application is an essential aspect in TDM.

In this paper TDM is defined by the processes “determination”, “pre-processing”, “application” and “administration” of time data in the field of industrial engineering (see Figure 3).

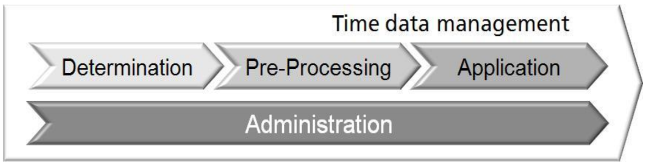

Figure 3 - Processes of time data management.

Time determination specifies time values for defined work content. Several different methods to determine time such as time study, estimating and comparing or predetermined motion time systems (PMTS) are used for this purpose. These determined time values are usually not directly applicable. They have to be pre-processed application-oriented (statistically evaluated) or depicted as a function of time-determining factors.

The application process provides time data for strategic and operative issues in a company. Therefore a modern TDM is not just a mere data management. It strives towards a target-oriented application of time data for several tasks, such as identifying and performing of time-related improvement actions in production systems [18, 19]. Time data administration accompanies other processes of TDM. Nowadays it is often IT-supported in different systems along product emergence or special TDM-systems. A manual administration is still common in practice despite a large dissemination of digital administration systems.

This paper presents first results in developing a structure to specify relevant criteria describing the required competencies for TDM and focuses on time data determination.

5 INDUSTRIAL ENGINEERING COMPETENCIES IN TIME DETERMINATION

The following compilation of attributes represents comprehensive and structured competencies to determine time and emerged on one side from a through literature review considering TDM’s state-of-the-art. On the other side the attributes are based on the author’s experiences gained in industrial application and in research projects. Subsequently the attributes specifying the TDM competencies focussing on time determination are listed in Figure 4 depicting a basic selection of competence-specifying attributes but raises no claim to completeness. These exemplary attributes represent - some kind of - „checklist“ to ensure an comprehensive view on time determination competencies and are raised in the current situation in order to identify fields for improvement. The competencies are described subsequently.

5.1 System competence

In addition to the understanding of all processes of TDM, time determination in different types of production and different phases of product emergence is important to develop system competence. Type of production represents the repetition rate of production processes [20]. Additionally the organisation level of processes and work systems as well as the perfection and routine of employees are indicated. Type of production is also an indicator for selecting a suitable method of time determination [21]. Time determination depending to the phase of product emergence specifies if time data is determined pre- or post-start of production (SOP). Different constraints (e.g.

which time-influencing factors are known) have to be taken into consideration depending on PEP's-phase in determining time data or selecting suitable methods of time determination.

5.2 Methods competence

The attribute with the highest relevance in methods competence is the ability to apply different time determination methods. They are generally distinguished in methods to determine actual or target times. Actual times are specified by an observer measuring tasks directly at a work place (e.g. time study), by asking the worker (e.g. inquiry), through the worker himself (e.g. self-recording) or by automatic data collection by machines (e.g. registering by devices) [3, 22, 23]. Target times are derived from actual times and their time-influencing factors [24]. The reproducibility of work method descriptions and the accuracy of time data is significantly influenced by the methods of time determination.

Depending on the selected time determination method industrial engineers have to deal with different tools. The choice of determination tools ranges from a conventional application of (stop-) watches and paper, via specialised time determination means (e.g. digital recording board) [3] to the application of modern, universal devices (e.g. smart phones, tablet PCs) with TDM software tools or plant data collection systems. According to the selected methods and tools different determination rates can be achieved. The determination rate is defined as the ratio between the work content and the effort to determine this work content. Various time determination methods cause different expenditures in observing and evaluating work contents. These expenditures rise depending on an increasing accuracy of time data. For one-time time observation the determination rate is approximately one-to-one. Utilising analytical methods of time determination such as PMTS this ratio may rise up to one-to-two hundred with MTM-1 [3, 21].

TDM distinguishes different types of time. From an employee-oriented point of view especially actual times, target times, standard data, normal times and time standards are relevant [25]. For time determination only actual and target times are relevant. Actual time is defined as the duration of a really performed task. The target time indicates the time for a planned task [26].

The level of time category indicates the level of detail in segmenting time categories for humans and machines. The level corresponds to the hierarchic time category structure by REFA (see Figure 5) . Level I represents the order time for humans that is the holding time for machines. In level II these times are subdivided to setup and run times referring either to quantity units or orders. Time per unit – an important figure in work and time study – is also assigned to this level. In level III the fact is caught, that for performing a work process besides basic times also rest and allowance times are required [22, 23]. The segmentation in several categories of basic time and allowance time takes place in Level IV. Level V finally depicts a segmentation of basic time into influential and non-influential working time. In applying this structure in practice it is challenging to define a suitable level of detail.

Depending on the area of determination different methodical competencies are necessary. Thereby this attribute describes those areas in a company, where time data may be determined. Its characteristics are defined with production, assembly, maintenance and logistics (transport and storage in procurement and distribution).

5.3 Problem solving competence

In order to support continuous improvement processes competencies to recognize the necessity to actualise time data is important for problem solving within TDM. Actuality of time data focuses the contemporary relevance of work methods underlying time data. In this way it declares how

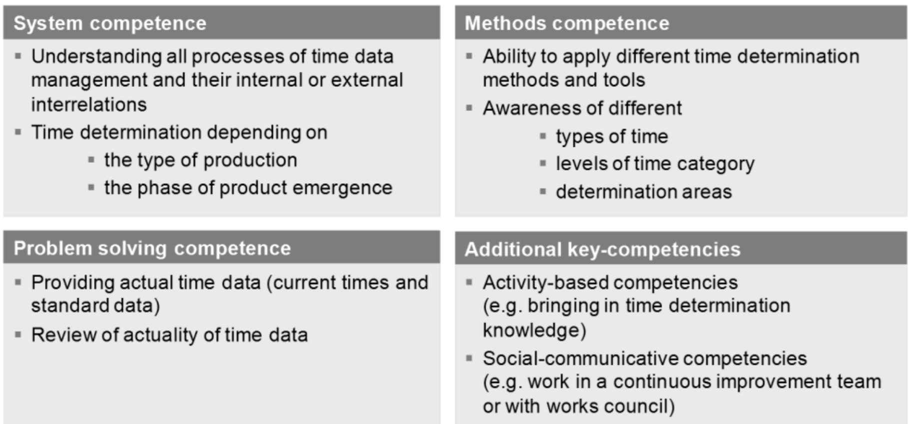

Figure 4 - Attributes to specify TDM competencies focussing on time determination.

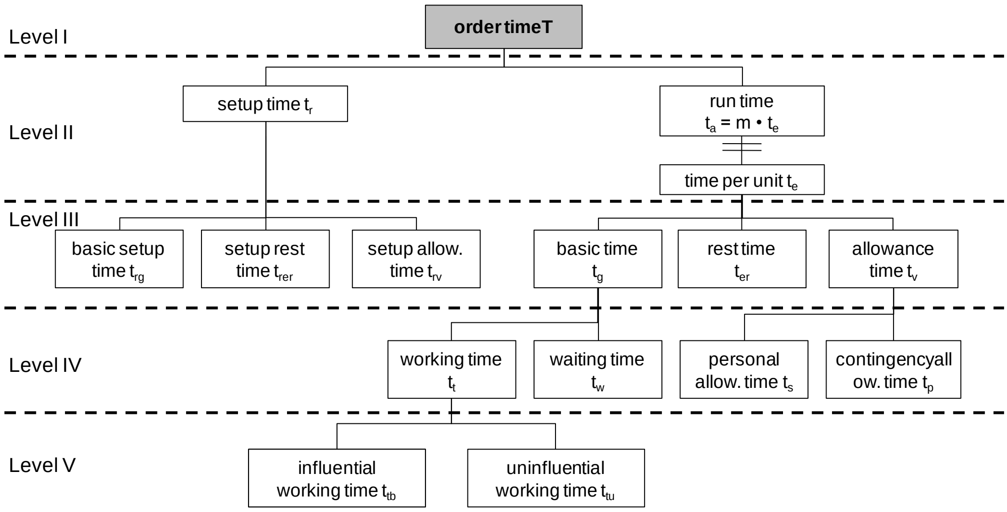

Figure 5 - Level of time category (human) [27].

accurate time duration represents the appertaining work content. Review of the actuality of time data states how regularly time data is checked and actualised in a company.

5.4 Additional key-competencies

Activity-based competencies in TDM imply high level of qualification and experience to distribute time determination knowledge. A novice e.g. is an employee being able to understand TDM-related coherencies and is aware of certain methods of time determination without being able to bring in time determination knowledge. Activity-based competence exists if employees are not only able to determine time for an intended purpose but also to transfer knowledge in form of training and coaching [28]. The social-communicative competencies require the ability to act self-organized in a group, e.g. in continuous improvement groups, during the time studies or during the agreement process with the works council. They have to be involved in case of remuneration in general and specially in performance-oriented remuneration. An agreement is not necessary, if time data is not used for remuneration.

6 CONCLUSION AND OUTLOOK

The renaissance of industrial engineering reveals that classical tasks in work measurement are again equally relevant as approaches and concepts to increase productivity systematically and both require TDM as an essential fundament.

The presented structure to specify relevant criteria describing the required competencies for TDM offers an orientation guide as well as a decision aid in developing modern time determination competencies. From a managerial point of view this compilation of attributes represents the required system, methods, problem solving and key-competencies and subsequently provides the fundament for developing comprehensive TDM-related competencies. For future research the complex field of TDM's competences should be represented comprehensively. It will provide the basis for establishing a comprehensive TDM-related competence management in manufacturing companies. .

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