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Integrating Competences into Work Planning – The Influence of Competence-Based Parameters on Strategic Business Objectives

G. Meyer, M. Klewer, P. Nyhuis

Abstract**—**Constantly changing economic conditions require companies to design their production to be more economical, innovative, and flexible. Since workers have a decisive influence on cost, time, and quality, e.g. by monitoring indicators that determine quality, by developing processes more resistant to disturbances, or by monitoring environmental standards, a focus on personnel as a production factor is needed. This presupposes the efficient use and systematic enhancement of employees' existing competences since greater consideration of these aspects in work planning will help to enhance competitiveness. The aim of the research project 'Integrated Technology- and Competence-based Work Planning in Socio-Technical Systems' is to develop a new work planning method that combines technology with work science by incorporating employees' skills as a quality indicator. For employee competences to increase competitiveness, it is first of all necessary to assess how competences affect cost, time, and quality. A model for deriving predictions about the effects of competence-based parameters on these strategic business objectives is developed in this paper.

Keywords**—**Competence management, education and training, employee competences, one-factor-at-a-time method, work planning.

I. Introduction

INCREASING competition and rising customer demands compel production companies in Germany to design their manufacturing processes to be more economical on an ongoing basis [1]. This calls for more efficient use of personnel as a production factor, which in turn implies more efficient use and systematic enhancement of employees' existing skills [2]. Additionally, the preservation and promotion of employees' competences is gaining importance in the light of the demographic change in Germany [3].

The systematic inclusion of employee competences in the process of product development enables work planning to offer great potential for increasing the efficiency of manufacturing by generating increasingly accurate development strategies [4]. "Work planning includes all nonrecurring planning measures, which, with constant regard for economic feasibility, ensure the manufacturing-oriented configuration of a product or the approach-based design of a service." [5, p. 195]. A distinction is made here between technology-based and labor science approaches. Whereas the focus of the first is on the efficient use of technology, the second aims to achieve the best possible organization of working conditions and competence-based work planning. The disadvantage of a purely technology-based approach is the lack of emphasis on personnel and their particular skills. The work science approach, however, mostly disregards a company's strategic objectives and is therefore hardly applied in practice. In the future, both approaches will have to be combined to a greater extent to increase competitiveness (Fig. 1).

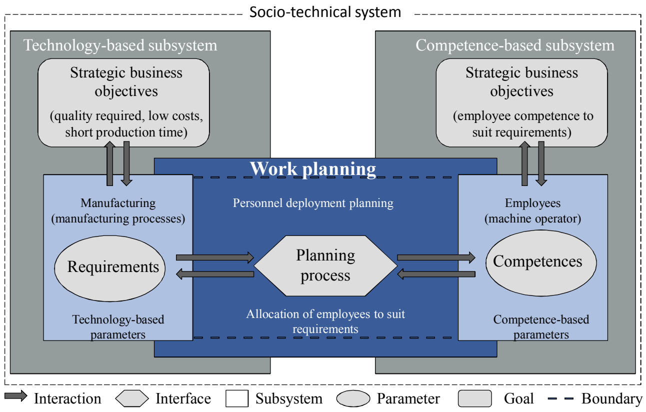

Fig. 1 Relationship between technology- and competence-based work planning [6]

This challenge is addressed within the research project 'Integrated Technology- and Competence-based Work Planning in Socio-Technical Systems'. The objective is to develop a new method of integrated technology- and competence-based work planning that combines technology with work science by incorporating employees' skills as a quality indicator in work planning (Fig. 1) [6]. This will help to increase a company's existing potential to achieve its strategic objectives. This requires, first of all, an analysis of the relations between competence-based parameters and a company's strategic business objectives. In a second step, a methodology for integrated work planning can be developed. A model that derives predictions about the effects of competence-based parameters on the strategic objectives of cost, time, and quality is presented in this paper. Which competences influence strategic business objectives will be pointed out with the help of an experimental design. These

G. Meyer is a PhD student at the Institute of Production Systems and Logistics, Leibniz University of Hanover, 30823 Garbsen, Germany (phone: 0049 511 762 18127; e-mail: meyer@ifa.uni-hannover.de).
M. Klewer is a M.Sc. student at the Leibniz University of Hanover, Germany (e-mail: martha.klewer@freenet.de).
P. Nyhuis is the head of the Institute of Production Systems and Logistics, Leibniz University of Hanover, 30823 Garbsen, Germany (phone: 0049 511 762 2440; fax: 0049 511 762 3814; e-mail: office@ifa.uni-hannover.de).

predictions will enable companies to identify strategically relevant employee competences.

II. Employee Competences in Work Planning

A refinement of the strategic parameters cost, time, and quality is needed in manufacturing. Whereas initially the primary focus of companies was to lower costs, recently the factors time and quality have been receiving more and more attention [7]. Moreover, alongside the aforementioned variables, flexibility and innovation have also gained in importance [8], [9]. The degree to which strategic business objectives are achieved can be measured with help of a variety of characteristics as presented in Fig. 2.

From a microeconomic perspective, the goal is to increase productivity, reduce costs, and improve logistics while simultaneously enhancing quality. However, from a work science perspective it is also important to maintain employees' health and to refine their competences [2]. "Competences are abilities for the self-organization of human activities, including creative thinking processes; they are a means of self-organizing. Unlike other constructs such as skills, knowledge, qualifications, etc., competences come to terms with the existing self-organization capabilities of the specific individual." [10, p. 365]. They differ from qualifications in that they enable individuals to solve problems in complex situations [10]. Competences can be grouped into four types: professional, methodical, social, and self-competence [11].

Professional competence refers to the knowledge and skills of an employee that are necessary for him or her to perform professional duties. This includes an understanding of relationships between workflows (process knowledge) and the knowledge related to work equipment and materials (specialized knowledge) [3], [12], [13].

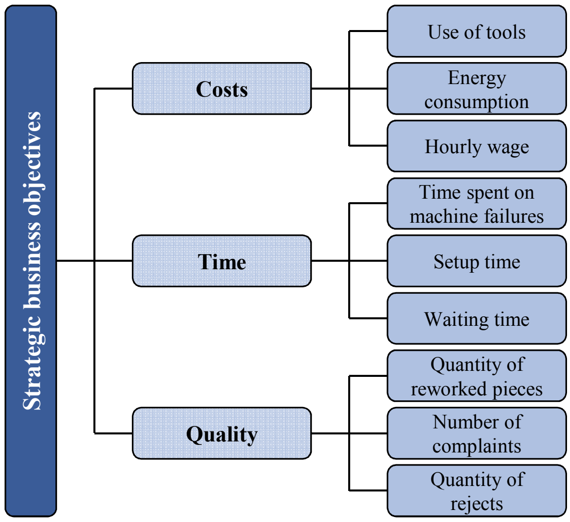

Fig. 2 Overview of strategic objectives

The cognitive ability to acquire new working methods independently and to absorb new technical expertise is called methodical competence. It implies methodical problem-solving skills, the proper performance of professional duties in various situations, a rapid adaptation to changing working conditions, and a smooth transition to new working places [12]–[14]. Social competence refers to having the ability, knowledge, and experience to handle various social interaction situations. It includes social problem-solving skills as well as the capacity for cooperation and teamwork. Social competence also covers communication skills and eloquence [12], [13].

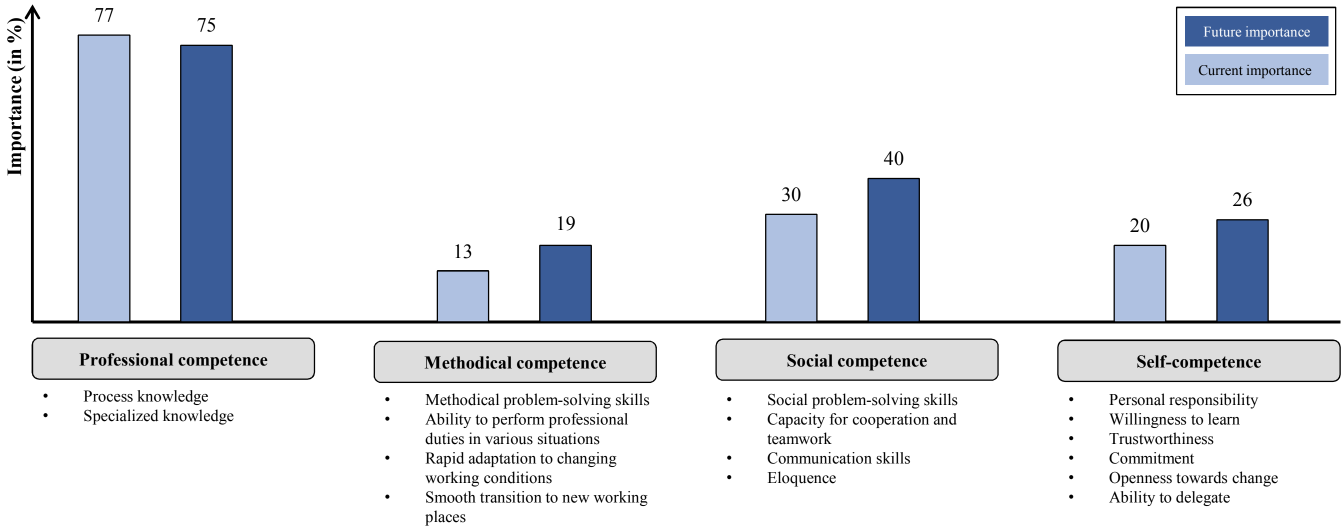

Fig. 3 Summary of competence-based parameters identified

Finally, self-competence refers to the ability of individuals to self-reflect as well as to their values and attitude toward work. Personal responsibility, the willingness to learn, trustworthiness, commitment, openness toward change, and the ability to delegate are attributes of self-competence [12], [13]. Together, all the skills mentioned above are hereinafter referred to as competence-based parameters.

A survey among more than 100,000 European companies found that 77% of companies currently rank professional competence highest, contrasting with social competence (30%), self-competence (20%), and methodical competence (13%), which are not at the forefront. According to the companies' self-assessments, the importance of professional competence will decrease slightly in the future (75%), and social competence (40%), self-competence (26%), and methodical competence (19%) will become more important (Fig. 3) [15].

Employees' competences fluctuate, and their occurrence is highly situation-specific and impacts on a company's productivity [15]. If an employee does not possess adequate competences, he or she will not be able to execute a task appropriately, which in turn leads to a drop in productivity. In this context, competence management is of particular significance. Competence management, according to NORTH and REINHARDT, is "a management discipline with the task of describing skills and making them transparent, as well as ensuring the transfer, utilization, and development of competences based on the personal goals of the employee and the business venture" [14, p. 16].

The resulting demand for work planning is thus not only to take into account technological requirements, but to involve employee competences into the planning process, too. Efficient use of the intangible asset "employee competence" benefits product and process quality as well as a company's innovation capacity and adaptability [2]. The systematic development of skills in the context of competence management in conjunction with work planning also increases a company's flexibility when responding to market fluctuations [16].

III. Methodology

The first period of the research project 'Integrated Technology- and Competence-based Work Planning in Socio-Technical Systems' included the identification and assessment of the technology- and competence-based parameters relevant to work planning. The cause-and-effect relationships have been arranged in matrices where, firstly, interactions among technology-based parameters and, secondly, interactions among competence-based parameters are displayed. In a third matrix, interactions between the technology- and competence-based variables are analyzed and presented.

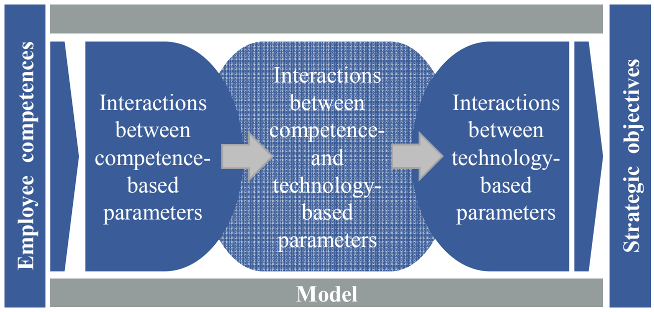

Fig. 4 Conceptual design of the model

In order to investigate the influence of competences on strategic business objectives, the three matrices were merged into one model (Fig. 4). The 16 competence-based parameters identified constitute the input variables, and the strategic objectives cost, time, and quality represent the output quantities. Varying the input parameters results in a change in the output measures and thus allows an investigation of the impact of competences on strategic aims.

A sensitivity analysis was used to examine the qualitative relationship between technology- and competence-based parameters as such an analysis makes it possible to determine the influence of an explanatory variable on a defined output measure. In order to differentiate the influence of different parameters, only one input variable is changed at a time while all other factors remain constant. This method makes it possible to analyze individual explanatory variables that are largely independent of each other. Furthermore, interactions between explanatory variables remain untouched. Sensitivity analyses are used to analyze uncertain data and to identify weaknesses in the model [17], [18]. A common method for sensitivity analysis was used in this project: the one-factor-at-a-time method. The advantages of this method are its rapid adaptability with regard to changing conditions, new insights with every run, and its ability to search for a maximum efficiently. The disadvantages include a high time investment, the lack of consideration of interactions, an inability to guarantee an optimum result, and difficulty in generalizing conclusions [19]–[21].

In a one-factor-at-a-time design, levels are defined that can be adopted by the explanatory variables. For this purpose, the employee competences described were depicted on a five-point scale:

1. Competences Available to a Limited Extent

The employee has a very low level of knowledge or skills necessary to perform a job and makes many mistakes.

2. Competences Partially Present

The employee has some of the knowledge or skills necessary to perform a job, but cannot work independently without fault.

	Parameter/Setting	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	...	69
Professional competence	Process knowledge	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	...	5
	Specialized knowledge	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	...	5
Methodical competence	Methodical problem-solving skills	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	...	5
	Ability to perform professional duties in various situations	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	2	...	5
	Rapid adaptation to changing working conditions	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	...	5
	Smooth transition to new working places	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	...	5
Social competence	…	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	5
Self-competence	…	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	5
Strategic business objectives	Costs	-2,1%	-0,7%	-3,6%	-1,8%	-1,8%	-1,8%	-1,8%	-2,1%	-2,1%	-2,1%	-2,1%	-2,7%	-2,1%	-2,1%	-1,8%	-2,1%	-2,1%	-1,1%	...	2,1%
	Time	21,0%	20,4%	16,6%	20,4%	20,4%	20,6%	20,9%	21,0%	20,2%	20,5%	21,0%	20,6%	20,9%	20,6%	20,3%	21,0%	20,9%	11,0%	...	-21,0%
	Quality	-21,4%	-19,1%	-17,9%	-21,0%	-21,0%	-21,3%	-21,3%	-21,4%	-20,9%	-20,9%	-21,4%	-20,5%	-21,3%	-20,4%	-21,1%	-21,4%	-21,2%	-11,2%	...	21,4%

Fig. 5 Extract from the analysis using the one-factor-at-a-time method

3. Competences Present to a Normal Extent

The necessary skills and abilities are present to a normal extent. The employee can work independently under normal conditions without fault.

4. Competences Present to an Above-Average Extent

The employee possesses above-average knowledge or skills and is able to work independently under challenging working conditions without fault.

5. Competences Present to an Exceptional Extent

Excellent command of the knowledge and skills are necessary to perform a job. The employee always works without fault and supports colleagues.

In the beginning, all input factors (competence-based parameters) are placed on the first level and the result is evaluated. Subsequently, only one input factor is placed on the next level and the output is analyzed. Thereafter, this input factor is lowered again by one level and the next input factor is placed on the next highest level. This procedure is similarly performed for all explanatory variables (see Fig. 5). In the next step, this procedure is repeated for the second level and will continue to run until all the stages are passed through. The results of combining the respective stages are processed in a matrix, which displays the influence that specific explanatory variables have on strategic output objectives.

IV. Results

A total of 69 settings were examined and 207 values gathered and evaluated within the analysis. Fig. 5 shows an extract from the settings applied. This extract shows that only one input variable is changed at a time and that its influence on strategic objectives is analyzed correspondingly. The main results demonstrate that costs rise with increasing employee competences, but that time decreases significantly and quality is improved (Fig. 6). Hence, these findings correspond to the expectations [1], [22] and underline the reliability of the model developed.

Fig. 7 summarizes the results of the analysis. Striking here is how professional competence generally has a strong influence on strategic business objectives and how social problem-solving skills have a lack of influence. Moreover, there is no interaction between cost and the competence-based parameters ‘eloquence’ and ‘ability to delegate’ (Fig. 7).

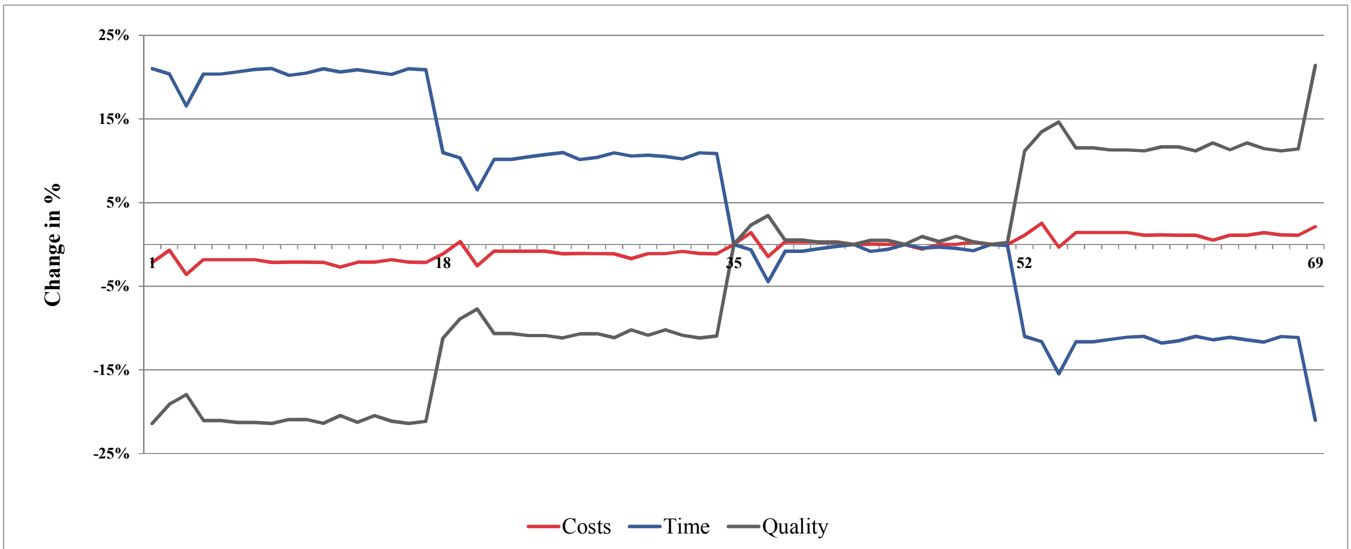

Fig. 6 Change of the strategic business objectives with increasing employee competences

On a more detailed level, the results show that professional competence has a major impact on cost, which can be attributed to a change in the competence-based parameter ‘process knowledge’. On the other hand, the competence-based variable ‘specialized knowledge’ strongly correlates with the strategic objective ‘time’ (Fig. 7).

	Competence-based parameters	Cost	Time	Quality
Professional competence	Process knowledge	++	-	++
	Specialized knowledge	--	--	++
Methodical competence	Methodical problem-solving skills	+	-	+
	Ability to perform professional duties in various situations	+	-	+
	Rapid adaptation to changing working conditions	+	-	+
	Smooth transition to new working places	+	-	+
Social competence	Social problem-solving skills	0	0	0
	Capacity for cooperation and teamwork	+	-	+
	Communication skills	+	-	+
	Eloquence	0	-	+
Self-competence	Personal responsibility	--	-	+
	Willingness to learn	+	-	+
	Trustworthiness	+	-	+
	Commitment	+	-	+
	Openness towards change	+	-	+
	Ability to delegate	0	-	+
Total influence of parameters on strategic business objectives:		+	-	+

++ Strong positive relation; + Positive relation; 0 No relation
-- Strong negative relation; - Negative relation

Fig. 7 Summary of results

It can be seen in Fig. 7, for instance, that an above-average level of methodical problem-solving skills is associated with an increase in costs while at the same time it reduces time and increases quality. However, the ability to delegate has no influence on costs, but brings about a reduction in time and an improvement in quality.

V. Conclusion

Employees’ competences increasingly function as differentiators and have a decisive effect on the long-term competitiveness of manufacturing companies. Work planning in particular must take greater account of this situation. Technology-based work planning does not yet consider employees’ competences. However, it is imperative to involve staff competences by linking technology-based and labor science approaches within a new, integrated method of work planning. This presupposes an analysis of the impact that competence-based factors have on strategic objectives.

Within the scope of the described research project, the aim was to develop a new method of integrated technology- and competence-based work planning that combines technology with work science. To achieve this overall objective, it is necessary to investigate the relationship between competence-based parameters and a company’s strategic objectives beforehand.

To this end, a model for deriving predictions of the effects of competence-based parameters on strategic objectives was created. Which types of competences make a difference for business outcomes was examined using the one-factor-at-a-time method.

The results reveal that improved employee competences increases costs, but decreases time and improves quality. Professional competence has a major impact on cost. A change in the competence-based parameter process knowledge leads to this visible effect. Specialized knowledge, on the other hand, strongly correlates with the strategic objective ‘time’. The social problem-solving ability has no effect on strategic objectives.

For the future, in order to increase the accuracy of the model developed, a more intensive study of the interactions between technology- and competence-based parameters is needed. This could help to complement and modify the model presented here. Furthermore, it is necessary to consider other analytical strategies instead of the one-factor-at-a-time method, e.g. a fractional factorial experimental method, in order to enhance the level of detail of the results. As part of the research project, the usability of the results has to be reviewed and, if necessary, the model has to be adapted to requirements arising from further processing steps.

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Dipl.-Wirt.-Ing. G. Meyer holds a Master's Degree in Industrial Engineering. He studied at the Technical University of Dortmund (Germany). Currently, he is a research associate at the Institute of Production Systems and Logistics at the Leibniz University of Hanover (Germany), involved in the study of industrial engineering and ergonomics, where he is pursuing a PhD.

M. Klewer (B.Sc.) holds a Bachelor's Degree in Industrial Engineering. She studied at the Leibniz University of Hanover (Germany). Currently, she is pursuing a M.Sc.

Prof. Dr.-Ing. habil. P. Nyhuis heads the Institute of Production Systems and Logistics at the Leibniz University of Hanover and is a member of the board of management of the Institute of Integrated Production, Hanover. He studied mechanical engineering at the Leibniz University of Hanover and subsequently worked as a research associate at the Institute of Production Systems and Logistics. He completed his habilitation thesis after receiving his doctorate in mechanical engineering.