The Concept of Ergonomic Analysis of a Company’s Organization of Working Time

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Keywords: ergonomics, working time, production system, working conditions

ABSTRACT

The aim of this article is to present the concept of the analysis of working time organization in a company and to present the results of empirical research. The analysis of working time organization is still a poorly recognized issue of economic analysis. The basic research problem of the research is to identify the organizational gap which is the difference between the applied working methods and the working time systems already in use, as well as to indicate a way to bridge this gap. The goal is to determine the suitability of the applied working time system to the type of working method of given department. The concept of the working method adopted in the article includes: elements of the production system, elements of the work system and working conditions. The proposed course of analytical proceedings (research methodology) includes the following stages: identification of organizational units within the enterprise and the working method used, analysis and evaluation of the working time system and identification of ways to improve the working time system. The empirical part of the article presents the results of an analysis and evaluation of the working time system in a steel industry enterprise (case study). The results of the economic analysis were complemented by management and employee feedback in order to improve the existing working time system. The following were used to achieve this objective: the research results, economic analysis, elements of ergonomic analysis, interviews and questionnaires.

INTRODUCTION

In the numerous and extensive literature concerning the organization and management of working time, issues of designing and improving the working time system in a company are particularly important. Authors dealing with this subject mainly pay attention to the formal and legal aspects of this phenomenon, the expectations and needs of employees, evaluations of equipment efficiency and

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work efficiency at a given time or the use of ergonomic principles in the process of improving working time systems (see, among others, [1], [2], [3], [4], [5], [6], [7], [8], [9])). There is no universal methodology for diagnosing the organization of working time which, by performing a diagnostic and developmental function, would contribute to bridging the gap between the working methods of the enterprise and the applied working time systems. It is worth adding that an increase in the variability of the environment and competition on the market in which the company operates requires the creation and improvement of working methods and appropriate working time systems.

In recent years, there has been an increasingly visible gap between the size and pace of technological innovation and organizational change, and the pace of change in working time systems. Moreover, and perhaps above all, time systems in companies are also lagging behind requirements resulting from competitive pressure related to costs, globalization of the economy, expansion of the customer market or the arrhythmia of social life. This discrepancy creates a particular organizational gap which is very costly for the company and the economy.

The growing organizational gap in working time is becoming an increasing problem for many enterprises and institutions, and filling this gap is an important research area. The identification of the scale of the problem together with an analysis of limiting conditions and examination of working time determinants, as well as indication of directions of possible actions aimed at minimizing or eliminating the organizational gap in working time, constitute an important objective and subject of research.

Often the proposed tool for adjusting the working time system to the current and future goals of the organization is to make working time more flexible, involving, among other things, extending and shortening working time according to the needs of the employer, which is limited by the provisions of labour law. This is not the only or most appropriate solution to the problem in question. For example, it can be stated that it is not enough when a low demand for labour is combined with a periodical arrhythmia, or even with long periods of complete lack of it.

The aim of the paper is to present the concept of the analysis of the organization of working time in a company and to present the results of empirical research. The basic research problem is to identify the organizational gap, which is the difference between the applied working methods and the used working time systems, as well as to indicate a way of bridging this gap. The goal is to determine the suitability of the applied working time system to the type of working method of a given department. The term working method is understood as an intentional and reproducible process leading to a result. The concept of the working method

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3 Modern technologies and new generations of numerically controlled machines and devices, by being more “intelligent”, eliminate the human being from the implementation of technological, auxiliary and maintenance operations and significantly reduce the demand for live work in the area of steering, control and supervision. Moreover, these devices require various forms of flexible employment and working hours in an extremely efficient and flexible manner.

4 The sharp increase in international competition is connected, among other things, with the fact that capital is invested in places where costs are low, especially labour costs. These costs are increased by not only high real salaries, social security contributions or high taxes on wages, but also by situations where the forms of employment and organization of working time guarantee stable conditions of paid employment, also in the absence of a demand for work and highly protected employee rights, regardless of the market situation.

5 Market outlets are becoming increasingly unstable and diversified customers are no longer loyal to certain producers and trading institutions; the survival of the market requires a rapid response to emerging or anticipated demand, which for its part also argues in favour of seeking new forms of working time organization.
adopted in the article includes: elements of the technical-technological and information system, elements of the working system and working conditions. The proposed course of analytical proceedings (research methodology) includes the following stages: identification of the organizational units within the enterprise and the working method used, analysis and evaluation of the working time system, identification of ways to improve the working time system. The empirical part of the article presents the results of an analysis and evaluation of the working time system in a steel industry enterprise (case study). To achieve this goal, the following research methods were used: analysis of research results of preceding studies, economic analysis, elements of ergonomic analysis, interviews, questionnaires.

Referring to research on the nature of time, it should be stressed that it is most often perceived in terms of resources and coordination. Taking both into account in the production process, it is necessary to define standards of working methods first and then to develop appropriate standards of time, especially working time. Although work is a form of effort, each unit of work requires time and includes the time it takes to complete it. In this context, time standards are essential for the analysis, planning and control of operations, coordination and scheduling, as well as for motivational work, human resources needs assessments and labour cost surveys.

It is worth adding that the inversion of this relationship in the process of management and manufacturing usually leads to activities that from the beginning run quickly and chaotically, thus contributing to changes in working methods and, as a result, to the redefinition (improvement) of time standards. This way of organizing production systems, i.e. setting time standards without taking into account working methods, is used by real companies as a strategy of competing with time. In other words, these issues, in terms of new technologies and management methods, require new solutions and time standards, e.g. changes in sales markets result in the shortening of the product life cycle which makes it necessary to shorten the cycle of preparation of new products, meeting the agreed deadlines or meeting short deadlines for delivery. Such procedures are usually highly risky and often result in failure, e.g. exceeding the deadline for the completion of the work.

WORKING METHOD AND ITS COMPONENTS

From among the numerous determinants of the production environment, selected were those that significantly and permanently shape the features of the working method and working time system, namely the elements of the technical and technological system, elements of the work system and working conditions.

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6Every human activity, regardless of its type, is determined by the passage of physical time. This also applies to working time, which is a condition of the existence of the work itself and a manifestation of changes taking place in it.
7These issues are widely discussed in the work of authors in the field of operational management [10], [11].
8Working time is the time during which the employee is at the disposal of the employer in the workplace or other place designated for the performance of work. However, the working time system is understood as a set of rules related to the organization of working time allowed by the labour law, consisting of provisions concerning standards of daily and weekly working time, the reference period, etc.
Companies using continuous production processes have limited opportunities to shape their working hours. For technical and technological reasons, less often economic, the production process cannot be interrupted, thus separating the working time of the company from the working time of the employee. The lower the continuity of manufacturing processes, the greater the freedom to regulate working time and adapt it to the employee's preferences.

The work system is understood as an integrated set of principles, tools and activities aimed at achieving the organization's objectives. Taking into account the ergonomic aspect, the work system indicates the possibilities of the best possible adaptation of the elements of the work system, i.e. tools, machines, work objects, motivation system, employees' competences, work process organization, as well as the physical and social environment to the growing needs and professional aspirations of increasingly better educated and more creative employees.

An important determinant of the working method is the perception of the system of working time by employees and, in the wider sense, of working conditions. For example, improving the working time system, as expected by employees, creates a healthy and safe working environment by eliminating the harmful effects of work on people, contributes to improving working conditions, gradually improving working comfort, increasing rest time and even job satisfaction and productivity.

In order to achieve the research aims and to verify theses, the author's original method was used, which includes in its scope:

1) the purpose, the subject matter and the scope of the analysis,
2) an analysis of the company's situation,
3) definition of the working method,
4) identification of the organizational units of the enterprise and the working method used,
5) analysis and evaluation of the working time system,
6) indication of the directions for improvement of the working time system,
7) modelling and designing a new working time system,
8) implementation and assessment of the effectiveness of the new system.

The following auxiliary methods were used at various stages: analysis of documents, labour law regulations, identification of ergonomic principles, interviews with the management staff, a questionnaire.

The analysis and evaluation process was based on the principles of a holistic approach, which allowed to precisely determine the usefulness of the applied working time system and to identify the organizational gap and ways to fill it by implementing a new solution to the working time system.

It should be stressed that the organizational gap results from the inappropriate combination particular elements (subsystems) of the working method and the working time system. In the research, the focus of the analysis was on identifying and bridging the organizational gap resulting from the lack of adaptation of the working time system to the subsystem of working conditions.
THE RESULTS OF EMPIRICAL RESEARCH

The study was carried out at Arcelor-Mittal Poland S.A. Zdzieszowice Coking Plant. The company, together with five other plants, forms a global group comprising about 70% of the production potential of the Polish steel industry. Its annual production capacity and output is 7.6 million tonnes of crude steel and 6.5 million tonnes of rolled products [12].

The coking sector in Poland is ranked eighth in the world in the ranking of coke producers. Its production capacity is estimated at around 11 million tonnes of coke per year. Arcelor-Mittal Poland S.A. has the largest share in domestic coke production. Zdzieszowice Coking Plant - 4.7 million tonnes, which is 42% of total production.

The company employs 1,695 people in 22 organizational units (see Table 1). In the planned system 561 people work in standard one-shift working time systems in the two-shift system 42 and in the continuous working time system 1092 people work on a four team shift schedule.

After a detailed analysis of the elements of the production system and the elements of the work system, three working methods were distinguished and the working time systems used in a given type of working method were characterized (see Table 2).

Table 1. Classification of organizational units by the type of working method used.

| Production                                                                 | Maintenance                               | Service                                      | Administration          |
|---------------------------------------------------------------------------|-------------------------------------------|----------------------------------------------|-------------------------|
| Rolling Mill Department, Firedamp Division I, I, II Carboniferous Section, Energy, Company fire brigade. | Maintenance and repair, Environmental Protection Department, Business Department. | Production planning and accounting, Management of raw materials of coke production, Sales, management of raw materials and supply chains, Quality support, Technology and quality support, Automation and control department, Health and safety at work. | Departments: IT, Finance, Accounting, Communication, Transport, Human Resources Management, Home affairs, Economy |

After a detailed analysis of the elements of the production system and the elements of the work system, three working methods were distinguished and the working time systems used in a given type of working method were characterized (see Table 2).

Table 2. The used working time system according to the unit's type of working method.

- **Production work**—uses a continuous 24/7 working time schedule, i.e. a team working time schedule.
- **Maintenance work** uses a standard, two-shift working time schedule.
- **Service and administrative work**— uses a standard, one-shift working time schedule.

Each of the three types of work has a system of working time adapted to the type of production and work, which is binding for the employees.

The working method in maintenance work is similar to the working method in service and administration departments. The working time system is also similar. In both instance, a standard working time system is used, however, service and
administrative work is carried out in a one-shift system and maintenance work is carried out in a two-shift system (see Table 3).

Table 3. The type of shift schedule according to the unit's working time system.

| Specification                  | Standard working time system | Continuous working time system |
|-------------------------------|-----------------------------|--------------------------------|
| Type of shift schedule        | One-shift and two-shift     | Four crew (team) working       |
|                               | working time schedule       | time schedule                  |
| Length of reference period    | One-shift schedule – 1 month| 16 weeks                       |
|                               | Two-shift schedule – 12     |                                |
|                               | weeks.                      |                                |

Source: own elaboration based on [13].

EMPLOYEES' PERCEPTION OF THE WORKING TIME SYSTEM

The opinions of employees and managers on the system of working time were collected by means of a questionnaire and interviews with the heads of organizational units. The questionnaire consisted of 13 closed-ended questions, including the following: age, seniority and education. More than 1,800 paper questionnaires were handed out and 356 completed forms were collected, i.e. 21% of the total.

About 75% of the respondents are 31-50 years old. Employees over 50 years and under 30 years of age constituted a similar percentage of the total number of the surveyed. An analysis of the employees' seniority shows that the largest share among the respondents was held by employees with seniority over 5 years (62%), every fourth employee with seniority over 1 to 5 years, and the remaining 13% - 1 year.

On the other hand, the analysis of the education of employees showed that 53% of the respondents had a secondary education, 24% had basic vocational education and 23% had a university education.

This analysis shows that the company has a stable and experienced workforce, which guarantees continuity of employment in its age structure.

Among the next 10 questions of the survey, the most important were related to the assessment of the used working time systems (Table 4).

The majority of the respondents, i.e. 54%, stated that the four-time working time schedule increases the arduousness of work, mainly due to night shift work, hinders sleep and rest after work and has a negative impact on the employees’ life outside of work. About 33% have expressed the opinion that this system has a negative impact on work and life outside the profession, but only to a small extent, the remaining 13% indicate that it does not have a negative impact.

Another point raised was overtime. Most often, it results from the acceptance of additional orders by the company, replacement of employees absent from work (absenteeism), as well as from the necessity to fix equipment failures. The majority (52%) of respondents have reported that at least 3-4 days a month employees are obliged to work overtime, 44% work overtime 2 days a month and the remaining 4% do not work overtime. This work, as all the employees surveyed emphasize, increases the arduousness of work, disorganizes their time outside of professional work (time available), especially when they are called to work in an emergency.
Table 4. Assessment of the used working time systems.

| Survey Questions                                           | Answers                                                                 |
|------------------------------------------------------------|-------------------------------------------------------------------------|
| Four-team work schedule affects the employees’ life outside of work | • No - 54% of the respondents,                                          |
|                                                            | • Has a small influence - 33% of the respondents,                       |
|                                                            | • No influence - 13% of the respondents.                                |
| Replacement of the four-time work schedule with another time system | • Definitely yes - 19% of the respondents,                              |
|                                                            | • Yes - 52% of the respondents,                                         |
|                                                            | • Other system would not be better - 29% of the respondents.            |
| Working on public holidays                                 | • 52% of the surveyed employees work overtime 3–4 days a month          |
|                                                            | • 44% of employees work overtime 2 days a month,                        |
|                                                            | • 4% of the respondents do not work overtime                            |
| Assessment of the standard systems                         | The disadvantages of the standard system include:                      |
|                                                            | • lack of working time flexibility,                                     |
|                                                            | • invariability in the activities performed and work monotony          |

The main disadvantages of the standard one-shift and two-shift systems, in the opinion of the respondents, are the lack of flexibility of working time, the unchanging nature of the activities performed and the monotony of work.

Interviews with managers and information gathered largely confirmed the opinions of the surveyed employees, however, managers gave more suggestions for improving their working time systems than employees (see Table 5).

Among the numerous proposals to improve the working time systems at the target Company, the most important one is to introduce a five-crew working time schedule instead of a four-crew system. This (five-crew) system in essence increases the number of working days in the reference period as compared to the four-crew working time schedule and thus reduces the burden of multi-shift work, as well as increases the employees’ work availability.

According to the respondents, the solution to mitigating the negative effects of multi-shift work is therefore to select the right employees for this type of work. From a physiological point of view, this would be a matter of employing individuals who adapt easier and faster. Adaptability depends on individual differences (between employees), and age is an extremely important factor. It turns out that in three-shift conditions the productivity of a worker over the age of 40 decreases.

In addition to physiological considerations, the adaptability of an employee is also determined by social considerations. Gender, marital status, family situation and, in particular, the number and age of children indirectly affect an employee's ability to adapt to night work. The employee's situation in this respect is best known by his or her immediate superior and it is he or she who should be involved in the employee's work schedule.
Table 5. Proposals for improving the working time system.

| Four-team working time system | • the introduction of five-team shift schedules instead of the four-tam system,  
|                              | • employment of additional persons in departments where the number of employees is insufficient, the introduction of temporary work system or outsourcing of employees  
|                              | • introduction of additional days off,  
|                              | • selection of employees for multi-shift work. |

| Standard system: one-shift and two-shift operation | • introduction of variable start and end times, additional breaks when possible,  
|                                                  | • introduction of a "Family Day" - the employee can finish work 2 hours earlier on Friday in order to spend time with the family,  
|                                                  | • greater involvement of managers and employees in drawing up work schedules,  
|                                                  | • introduction of modern methods of production and time oriented work management. |

An important part of employees working in two-team shifts is the flexibility of their working hours and the possibility of using rooms and facilities that enable them to relax and rest during their breaks from work.

It is also worth mentioning modern methods of production and work management, such as Flexible Manufacturing Systems (FMS), QRM or Workflow, which address issues related to time management. These systems perform the function of controlling production, and can be adapted and used to optimize work processes and control employment at different times, e.g. by reducing staffing where possible for afternoon and night shifts.

Summarizing the results of the research, it should be stated that the psycho-social effects of multi-shift work are unfavourable for both the employees and the Enterprise. On the other hand, important technological and economic reasons (working method) determine that the use of multi-shift work schedules is necessary for the functioning of the enterprise and improvement of management efficiency. Therefore, it is reasonable to strive for the improvement of this form of working time organization (working time system).

The significantly lower continuity of manufacturing processes, found in organizational units providing services and in administration departments, allows a greater freedom in regulating working time and adapting it to the preferences of employees, e.g. by using a flexible working time, shortening the working time on Friday by 2 hours (time for the family) or by providing rooms for rest and recreation for persons employed in two-shift systems.

**FINAL REMARKS AND CONCLUSIONS**

The analysis and improvement of the working time system in a company is still a poorly recognized problem of economic analysis. There is a lack of a universal methodology for diagnosing the organization of working time which in its essence
should perform a diagnostic, developmental and motivational function, constituting the basis for managing the working time resources at the company's disposal.

The presented methodology of analysis and improvement of the working time system in the company is based on the concept of the working method and the suitability of the applied working time system for that type of working method. It is worth mentioning that the increase in the variability of the environment and competitiveness on the market in which the enterprise operates requires the creation and improvement of working methods and, consequently, appropriate working time systems, such as the method and time system employed by freelancers.

In its strategy, the company should define the subject and scope of the analysis of its working time organization, paying particular attention to the chosen element (subsystem) of the working method, e.g. working conditions, and more specifically the perception of the working time system by employees. The information collected makes it possible to model the company’s working time system and identify the managerial pragmatism of the company in this respect.

It should be stressed that the working method is determined by many factors, and some of them shape the working method by acting as moderators, i.e. as regulating variables (e.g. labour law codes) or as moderators, i.e. as intermediary variables (e.g. trade union activities).

The research subject of this study was limited to the above mentioned elements of the working method.

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