STANDARDIZATION OF AUXILIARY AND SERVICING PROCESSES

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Abstract

This article deals with application of methods of work time analysis for determining of standards of auxiliary and servicing processes in the manufacturing industry. Firstly compendium of methods for measuring and utilizing work of handlers was created. The article follows advantages and disadvantages of all methods regarding their suitability for optimal run of the workplace and effective utilization of the workers. Results of the questionnaire survey focused on the use of methods for work time analysis in the manufacturing companies in the Czech Republic are also part of this article. Application of individual methods to specific company data with the view of verifying the applicability of these methods in practice can be found in the case study. In the final part of the article assumptions and recommendations are introduced for subsequent utilization of methods for determing number of workers in auxiliary and servicing processes.

Introduction

The setting of performance standards for direct production workers has been processed in detail by most corporations and the fact that task-wages are based on the performance standards significantly incites the management of production companies to inquire into this matter. In contrast, little attention is paid by the majority of such companies to the standardization of auxiliary and servicing work, even though workers such as maintenance workers, setters, and handlers performing so-called indirect labour - auxiliary or servicing work, form an essential part of any production. If these standards are set, it is on the grounds of estimates and experience in a given production section, and methodology of determining standards rarely exists there. What caused the long-term lack of interest in standardizing such jobs? The complexity of this task rests mainly in the difficulties surrounding the description of maintenance processes. Auxiliary work is influenced by a range of random events, which represents considerable complications when calculating its standards. In addition to the actual time values, the resulting standards for indirect labour also provide information on the economic intensiveness of given activities (in connection with cost functions), which in itself is an important bases for future managerial activities. Nowadays, when a great emphasis is placed on increasing work efficiency, the introduction of standards in the field of auxiliary and maintenance work represents an objective source of potential reduction of overhead costs.

Within the scope of work on this project, methodology was established that would allow plastic-processing manufacturers to put in place effective planning.

The main tool for achieving this goal is the selection of an appropriate method of time analysis, which objectively evaluates time consumption of individual work tasks. The introduction section of this article deals with general characteristics of different methods of time analysis and respective benefits of their use with regard to how this field is addressed in professional literature.The main aim of this paper on this subject is to select a suitable method for standardization of selected indirect labour (handlers) and to formulate conditions for its use in practise. The next objective is to create an overview on the subject of time studies and indirect labour standardization from both domestic and foreign literature, which could be used by managers and field specialists.

1 Methods for Determining Labour Input and Work Structure

The following chapter deals with the compendium of the methods which according to the professional literature objectively evaluates time consumption of individual work tasks in the auxiliary and servicing processes.

1.1 Monitoring of a Working Day

Monitored are all activities performed by a worker working on his own, inclusive of measuring their time utilization. The actual recorded data is entered onto an observation sheet. This kind of a working day snapshot comprises the most detailed record of all work activities and an uninterrupted monitoring of working time utilization during a shift. Instant monitoring partly replaces the traditional method of a working day snapshot. Its application is simpler and less time consuming for the observer. The principle of this method based on the probability theory and the theory of random choices lies in the time evaluation of a representative number of randomly selected short periods of time during a work shift. Evaluation of such samples corresponds with the results, providing that both comprehensive monitoring and all data collection are complete [1, p. 87]. Zonal and Multilateral Monitoring was developed to detect utilization of workers in non-stationary workplaces and combines simultaneous monitoring of work processes in designated zones with the use of suitable assessment software, where individual zones are defined by work operations performed there. Chronometry allows a thorough examination of the operations and time corrections, all without the actual use of a normative base, although its lengthy and laborious use poses a disadvantage [5, p. 134].

1.2 Predetermined time values methods

These methods are based on combination of time and motion studies. It divides manual labour into basic movements that are necessary for its completion. To each of such basic movements, a predetermined time value relates, determined by the nature of the basic movement and any influences that affect its implementation. The original MTM (Motion Time Method) is for setting indirect labour standards prohibitive because of its extreme labour intensity. Using the MTM method, it takes 8 hours for an analyst to process 1 minute of an operator’s labour. Basic MOST (Maynard Operating Sequences Technique) was developed based on the requirement to measure work faster than when using the MTM System, while maintaining the same accuracy level. Most companies use it in their production systems, but using it for the description of indirect labour is very restrictive due to its limited datacard of predetermined moves [6, 45]. A specific method Maxi MOST created directly for evaluating activities such as handling, transportation of goods on trucks, and bringing materials, i.e. activities connected with auxiliary and service processes in the production. Derived from the method MTM are

also UAS (Universal Analysing System), system SMA (Standards de Manutention Analytiques) and system SMB (Standards de Manutention de Basse). The UAS System links basic movements together in sequences that enables a rougher breakdown of types of grips, precision of location and length, and is therefore suitable for the description of indirect labour. SMA System and SMB System were developed specifically for measuring time consumption during material handling and in terms of its labour intensity level corresponds to the UAS System. However these methods are being used only in Francophone countries.

1.3 Other methods

The UMS (Universal Maintenance Standards) can be applied only when standardizing maintenance work on buildings or equipment. The system rests on two basic pillars: the definition of the range of work activities and time comparison of the individual activities [5, p. 201]. Normative Systems for Work Planning were created in the 1980s at the Institute of Work Planning in Heavy Industry. However, their use is nowadays limited due to their outdated data and their lack of normatives for operations that use electronic systems and other tools associated with the developments of recent years.

2 Methods for Setting Staff Number Standards

Methods for determining time standards can be divided in accordance with professional literature into two main groups: Analytical Methods and Summary Methods. An analytical method analyses work time, time of generally requisite breaks and time of conditionally requisite breaks. However, the method displays considerable inaccuracies when used in cases where standards are not met or exceeded, and where the amount of items in a batch varies. In the summary methods the time standard is determined by a single time value by means of regressive analysis, statistically, by summary comparison, or through estimates. A significant factor in deciding which suitable normative to select is the repetition of work. Both methods can be used when monitoring work in auxiliary and service processes such as maintenance and material handling. If the occurrence and duration of operations performed by staff is mainly of a random character, then queueing theory can be used for setting standards, which in turn enable the description of the course of the process for a different number of workers. Calculation of the number of workers from the operating standard is then based on the proportion between the number of operated units and the operating staff standard. Capacity planning should be based on a list of tasks that need to be done, on their priorities and on the usable time fund. The following sections describe the methods which can be applied when dealing with this issue.

- Analytical methods for setting staff number standards (Queueing Theory, Standardized Labour Input Method, Idle Time Method);
- Summary methods for setting staff number standards (Regressive Analysis).

2.1 Queueing Theory

The complexity of this method rests in establishing an accurate calculation model. In practice two basic undesirable situations occur in service work: operating staff are either overloaded and requirements thus accumulate, or there are not enough requirements on operating staff, resulting in idle time [2, 234]. The staff number standard, i.e. the optimal number of operating staff depends on the ratio between the unit value (costs and profits) of a time applicants spend waiting for operation and unit value of idle time of operating staff. In this situation the economic aspects must be taken into consideration, which include the cost of applicants

waiting in the queue and the costs of operating staff waiting (costs of service channels operation).

2.2 Regressive Analysis

The use of this statistical method is conditioned by a sufficient amount of input data. When determining the number of staff, this method monitors the dependency between individual aspects of a production process and the number of workers involved in this process [1, p. 111]. Input data for estimating regressive functions include information on the number of workers linked to a relevant group of machinery and the average size of a batch. The regressive analysis enables the estimation of the value of a certain random variable based on the knowledge of other variables.

2.3 Standardized Labour Input Method

The Standardized Labour Input Method is applicable on the condition that the scope of performed work is known and the time standards for all operations are available. This method essentially determines the overall scope of work and compares it with a usable time fund of an individual employee.

2.4 Idle Time Method

On the contrary, the Idle Time Method is based on establishing time when workers performing auxiliary and servicing work are not used to their full capacity. Based on the resulting time loss, the number of workers is subsequently reduced to the optimum. The method is particularly demanding in terms of basic data collection and their further evaluation [2, p. 209].

3 Questionnaire Evaluation

Within the scope of work on this subject, in the year 2010 an internet questionnaire survey was carried out focused on the use of methods for work time analysis in 25 medium-sized enterprises in the Czech car-manufacturing industry specializing in plastic components production.

To the answer ‘Would you welcome the use of a methodological handbook for standardization of indirect labour in your job?’ answered 82% of respondents yes, only 8% refused. According to other survey questions, standards of auxiliary and servicing work are being partly set in 4% of companies; the same result was for planning indirect labour capacities on the bases of standards. The only method used for standardizing auxiliary and servicing processes mentioned by respondents was the UAS system (see chapter 1.2). Finally, to the answer “Do you find currently available literature on the subject sufficient?” responded all addressed companies negatively. From the results of the research came out that little attention is paid by companies to the standardization of auxiliary and servicing work despite the fact that this subject pose problems for them. Majority of them do not solve these problems because there is no methodology available. Some achieved results are presented in the following chapter of the article.

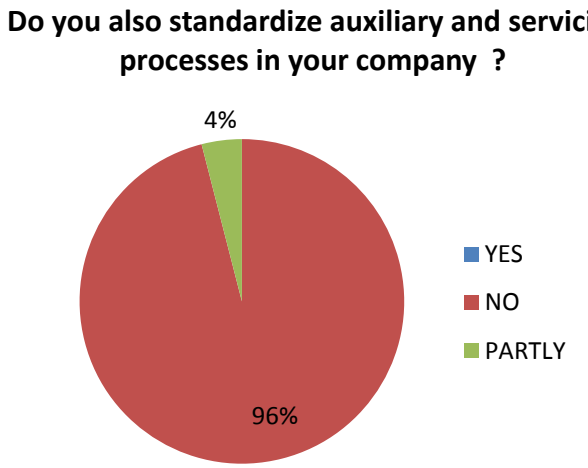

Fig. 1 Results of the questionnaire survey in the selected companies

4 Case Study

All methods were applied to data from a specific company with the view of verifying their applicability in production company conditions. The results clearly show that there is no universal method suitable for standardizing all types of indirect labour.The primary objective of the research in the given field is the selection of a suitable method for determining labour input and work structure. The most suitable method for measuring and analysing time usage that were used and applied to logistics work is the Maxi MOST. In this method, the datacard's range of indexes incorporates a large variance from one production cycle to another. The extended datacard of Maxi MOST offers a wider scope of predetermined times for the use of tools, instruments and various types of trucks (manual, stacker, high and low forklifts) typical for description of work in logistics. After compiling normatives in the system Maxi MOST, the authors of article see an ideal solution in creating a database system which would enable its users to perform measurements and obtain required data without the need for a deeper understanding of the principles of standardization. In turn, this would allow the group of potential 'evaluators' to be enlarged by people who have been only briefed about this system, which subsequently brings the desired simplifications and speeds up the process of creating indirect labour standards. The next step was to select and test a group of methods suitable for determining the number of workers in the logistical department.

4.1 Application of the Queueing Theory

The aim of research activity was to find out whether it is possible to set with queueing theory optimal number of fork lift truck drivers for required working area. Further it approached to check of current capacity utilization of fork lift trucks according to the costs. Total costs for internal factory transportation were calculated and according to equation (1) was found optimal number of operating staff.

Optimal solution with lowest costs for the company was found in the minimum of the function (1).

$$Nc(S) = \frac{\lambda}{\mu}(C - C_{SV}) + C_{SV}S + \frac{x\lambda C_w}{S\mu(S\mu - \lambda)} \qquad (1)$$

λ arrival rate;
μ service rate;
S number of service channels;
C cost of service capacity (cost per server);
Cw waiting cost;
Csv downtime cost;
Nc total costs;
x total number of requests per hour.

Fig. 2 Application of the queueing theory for determining the number of workers in logistics

4.2 Application of Regressive Analysis

On the example presented in the table 1 can be seen the dependency between individual aspects of a production process (labour intensity in standard-hours [Nh] and production volume) and the number of workers involved in this process. The regressive analysis enables the estimation of the value of a certain random variable based on the knowledge of other variables. In the table 1 can be seen difference between predicted standard and number of currently employed workers. This method is valuable especially within preparation of the predictive model for capacity planning. For creating of regressive function can be used any statistical software or MS Excel applications.

Regressive function resulted from this particular example:

$$Y = 0{,}03\,x_1 + 0{,}02\,x_2 \tag{2}$$

Tab. 1 Application of Regressive Analysis

Number of workers (y)	Labour intensity in standard hours Nh (x1)	Production volume (x2)	Regression Estimation	Difference between standard and reality
3	22.6	97	2.71	-0.29
4	25.9	120	3.29	-0.71
5	33.6	148	4.10	-0.90
6	43.1	181	5.08	-0.92
7	55.2	199	5.83	-1.17

Y - number of workers,

x_1 - labour intensity in standard-hours [Nh],

x_2 - production volume [number of packages].

4.3 Application of Standardized Labour Input Method

Methodology of the Standardized Labour Input Method is quoted in the monograph [2, p. 228]. It consists from following parts:

- Drawing up a list of work tasks that are to be completed within a given period;
- Determining labour input of individual operations in man-hours;
- Determining the overall labour intensity in man-hours, including the degree of fulfilment of standards;
- Determining usable time fund of an individual worker, or respectively the volume of idle time that cannot be eliminated;
- Determining the necessary number of workers according to the equation (3).

$$P = \frac{Q}{k_n F_c}, \tag{3}$$

P - number of workers

Q - overall labour intensity in standard-hours [Nh]

k_n - coefficient of fulfilment of standards

F - usable time fund in hours

Standard work shift fragments are according to equation (4).

$$T = t_{A1} + t_{B1} + t_{C1} + t_2 + t_3 + t_D + t_E + t_F \tag{4}$$

t_{A1} - work time for the unit;

t_{B1} - work time for the batch;

t_{C1} - shift work time;

t_2 - time generally requisite breaks;

t_3 - conditional requisite breaks;

t_D - individual lost time;

t_E - lost time due to organizational problems;

t_F - more superior lost.

Data about overall labour intensity of handlers in standard-hours (Q) was collected (by means of electronic system) in the selected workplace during one-year period. The objective was to set optimal number of handlers in this workplace with application of Standardized Labour Input Method.

Q = 25 628,5 Nh/year;

Usable time fund F_c = 7848 Nh/year;

Effective time fund = 6407 Nh/year, this implies k_n = 0.82;
Number of handlers according to equation (3):

$$P = \frac{25628.5}{0.82 * 7848}$$

P= 3.98 (round up to 4).

There should be 4 handlers in the particular workplace after application of Standardized Labour Input Method. According to the effective time fund handlers are used to 82% of their capacity.

4.4 Application of the Idle Time Method

Regarding the results from the previous example (where 4 handlers were in the particular workplace used to 82% of their capacity) can be the shift time according to the Idle Time Method separated into following fragments:

T_1 (work time) = 82%;

$T_2 + T_d$ (time generally requisite breaks + individual lost time of the worker) = 5% + 5% = 10%;

T_e (lost time due to organizational problems) = 8%.

According to the analysis are the handlers in the particular workplace not used to their full capacity. From the total time loss (18%) can be almost 10% reduced by the improvements and proceedings preventing from production downtimes, lack of material, insufficient supplies and unplanned change of production.

4.5 Classification of the methods

The analyzed methods were divided into two groups; initially into a group of methods determining time usage and structure of work (table 3), and subsequently into a group of methods suitable for determining the number of workers (table 4). According to criteria the individual methods in both groups were then sub-divided into categories A-C in line with their suitability for the use in the plastic-processing industry.

Tab. 2 Method Classification

Method Classification A-C	Conditions for Use of Method for Describing Indirect Labour
Category A	Method suitable without limitations.
Category B	Use of method suitable under certain conditions.
Category C	Use of method for description of given activity unsuitable.

Tab. 3 Overview of the methods for measuring and analysing time usage that were used and applied to logistics work in the plastic-processing industry

Method	Suitability of Method	Category	Justification of suitability/unsuitability of use
Working Day Snapshot	YES	A	Particularly suitable for collection of primary data.
Instant Monitoring	YES	B	Suitable in uninterrupted flow operations.
Zonal/Multilateral Monitoring	YES	A	Suitable for material supply and warehouse work.
Continuous Chronometry	YES	A	Suitable, providing that monitored tasks occur in regular sequence.
Selective Chronometry	YES	B	Partially suitable, for irregular operations.
Instant Measuring	YES	B	Suitable for irregularly repeating operations, for small production batches.
MTM	NO	C	Unsuitable, disproportionate labour intensity of data processing.
Basic MOST	NO	C	Unsuitable, does not allow description of necessary operations.
Maxi MOST	YES	A	Suitable, allows complete description of all operations.
UAS	YES	A	Suitable, using movement cycles.
UMS	NO	C	Unsuitable, does not contain description of given activities.
SMA	YES	B	Suitable as per methodology, but data unavailable.
SMB	YES	B	Suitable as per methodology, but data unavailable.
Systems of Normatives	YES	B	Applicable method, but data not updated.

Tab. 4 Selection of method for setting standards for staff numbers in plastic-processing plant logistics

Method	Suitability for use in plastic-processing industry	Reason
Standardized Labour Intensity Method	YES	Providing that database of normative is created.
Queueing Theory	YES	Description of randomly arising requirements.
Regressive Analysis	Partially	With sufficient volume of data, comparable with actual situation.
Idle Time Method	YES	Laborious in terms of data collection, suitable also for improvements.

Conclusion

The main objective of the article was to analyse various methods for standardization of indirect labour and formulation of conditions for their use in the plastic-processing industry. Methods were firstly applied to a selected group of logistics workers. Suitable methods were then selected based on the results, which were recommended for the description of these activities in the plastic-processing industry. System Maxi MOST was selected as the most suitable method. This system offers a wider scope of predetermined times for the use of tools, instruments and various types of trucks (manual, stacker, high and low forklifts) typical for description of work in logistics. Secondly, the established values were used with the purpose of determining which of these methods are appropriate for determining the optimal number of workers needed for executing a given activity. It is not possible to determine a universal method for setting labour standards in logistics on the bases of the completed analysis. Material handling, much like other overhead activities, is affected by time variability and fluctuation of workload. As a result from this research, the methods listed in the tables 3 and 4 are possible to select depending on specific conditions and on variation and repetition of performed work. Despite this fact it is possible to predict that selected methods should have broader applications for planning indirect labour in the medium-sized enterprises in the car-manufacturing industry specializing in plastic components production. The next step of the research will be selection of the suitable methods for standardization of other indirect labour (setters and workers in maintainance), formulation of conditions for their use in practice and subsequent proposal and creation of a model for indirect labour capacity planning.

Literature

[1] HŰTTLOVÁ, E. *Organizace práce v podniku.* 1st ed. Prague: Vysoká škola ekonomická, 1999. 128 pgs. ISBN 80-7079-778-9.

[2] KROUPA, V. *Racionalizace pomocných a obslužných procesů výroby*. 1st ed. Prague: SNTL, 1985. 251 pgs.

[3] LHOTSKÝ, O. *Organizace a normování práce v podniku*. 1st ed. Prague: Aspi, 2005. 85 pgs. ISBN 80-7357-095-5.

[4] WESTERKAMP, T.A. How to Use Work Measurement for High-Productivity Maintenance Operations [online]. [cit. 2010-08-01]. Available from WWW: <*http://www.pninc.com/maint/articles/MaintWkMeas0102.pdf*>

[5] NIEBEL, B. *Motion and Time Study*. 9th ed., McGraw-Hill Higher Education, 1992. 880 pgs. ISBN 9780256092486.

[6] ZANDIN, K.B. MOST *Work Measurement System*. 3rd ed.: CRC Press, 2003. 758 pgs. ISBN 0-8247-0953-5.

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STANDARDIZACE POMOCNÝCH A OBSLUŽNÝCH PROCESŮ

Tento článek se zabývá aplikací metod určení časové spotřeby práce pro stanovení norem pomocných a obslužných prací v průmyslové praxi. V rámci práce na tématu byl primárně vytvořen přehled základních metod, které se dají využít při normování práce manipulantů. Článek sleduje výhody a nevýhody použití těchto jednotlivých metod a shrnuje jejich přínos s ohledem na optimalizaci chodu pracoviště a efektivního využití pracovníků. Součástí článku jsou i výsledky dotazníkového šetření zaměřeného na zmapování používání metod časové analýzy práce v průmyslových podnicích v ČR. V případové studii jsou pak jednotlivé metody aplikovány na data konkrétního podniku s cílem ověřit použitelnost těchto metod v praxi. V závěru článku jsou uvedeny předpoklady a doporučení pro další užití metod pro stanovení počtu pracovníků v pomocných a obslužných procesech.

DIE BESTIMMUNG VON NORMEN DER HILFS- UND BEDIENUNGSARBEITEN

Dieser Artikel beschäftigt sich mit der Anwendung von Methoden zur Festsetzung des zeitlichen Arbeitsaufwands für die Bestimmung von Normen der Hilfs- und Bedienungsarbeiten in der Industriepraxis. Im Rahmen der Arbeit an dem Thema wurde primär eine Übersicht von Grundmethoden geschaffen, die man auch bei der Arbeitsnormierung der Manipulanten anwenden kann. Der Artikel analysiert die Vor – und Nachteile der einzelnen Methodenanwendungen und fasst ihren Beitrag zusammen, mit Rücksicht auf die Optimierung des Arbeitsganges und auf effektive Ausnutzung der Arbeiterskräfte. Der Aufsatz beinhaltet auch die Resultate eines Fragebogens, der sich auf den Gewinn einer Übersicht über die Benutzung von Methoden der zeitlichen Arbeitsanalyse in Industriebetrieben in der Tschechischen Republik konzentriert. In der anliegende Studie sind dann einzelne Methoden zu den Angaben des konkreten Betriebes appliziert, mit dem Ziel, die Anwendungsmöglichkeit dieser Methoden in der Praxis zu beweisen. Am Ende des Artikels sind die Voraussetzungen und Empfehlungen für weitere Methodenanwendung zur Bestimmung der Arbeiteranzahl in Hilfs – und Bedienungsprozessen angeführt.

STANDARYZACJA PROCESÓW POMOCNICZNYCH I OBSŁUGOWYCH

Niniejszy aktykuł dotyczy wdrażania metod określania czasu pracy niezbędnego w celu ustalenia norm prac pomocniczych i obsługowych w przemyśle. Analizując omawiane zagadnienie w pierwszej kolejności opracowano wykaz podstawowych metod, które można wykorzystać przy normowaniu pracy osób obsługujących.. Artykuł poświęcony jest zaletom i wadom związanych z zastosowaniem tych poszczególnych metod, podsumowując ich korzyści pod kątem optymalizacji sposobu funkcjonowania stanowisk pracy oraz efektywnego korzystania z pracy pracowników. Artykuł obejmuje ponadto wyniki badań ankietowych dotyczących stosowanych metod analizy czasu pracy w przedsiębiorstwach przemysłowych w Republice Czeskiej. Następnie w studium przypadku poszczególne metody zastosowano do realiów konkretnego przedsiębiorstwa w celu sprawdzenia możliwości wykorzystania takich metod w praktyce. W zakończeniu artykułu zostały opisane założenia i zalecenia w celu dalszego wykorzystania metod ustalania liczby pracowników zatrudnianych w procesach pomocniczych i obsługowych.