An OWAS-based Analysis of Storekeeper Workloads

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Since 1950s' attention has been paid in enterprises to customize complex technical structures to meet worker's needs. However, work creates negative for worker's health static posture which adversely affects worker's workload. The following research paper introduces certain problematic aspects of static load risk management of staff employed. The issue in question is quite relevant in warehouse labour ergonomics as well as effective organization and handling of tasks. The paper discusses OWAS method as a means to evaluate worker's workload. It also presents the employment of the method to analyse storehouse workload.
Key words: inventory control, OWAS method, workload.

Technological advancement causes considerable change to the worker's position in industrial system. A worker ceased to mean 'strength and energy required to perform a technological task'[1]. At present his function is to operate technical devices and to do ancillary jobs.

Technical equipment 'compels man to continuously perform the same simple actions'[2] and creates static posture negative for worker's health (fig. 1).

Long maintained static posture impairs proper tissue nutrition and blocks the necessary oxygen inflow to muscles. As a result of permanent muscles tension, owing to static posture, they become stiff and painful. It is the result of static load (overload). Static effort is performed during work in stagnant conditions. It is associated with the necessity to maintain uncomfortable and/or compulsory body posture[3].

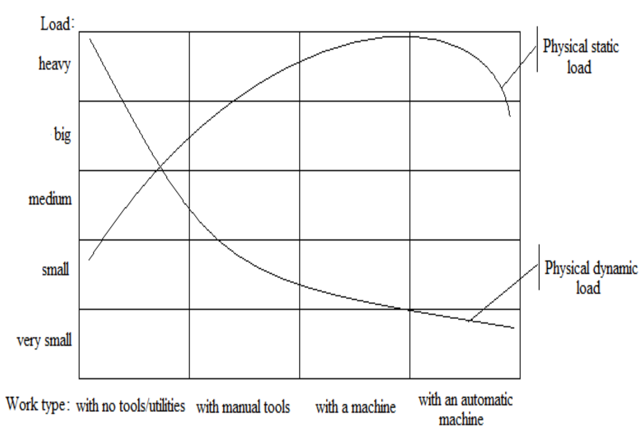


Figure 1. Changes in worker's load when working with the use of technical means; Analysis by: Tytyk E., *Projektowanie ergonomiczne*, PWN, Warszawa-Poznań 2001, s. 45

[1] Tytyk E., *Projektowanie ergonomiczne*, PWN, Warszawa-Poznań 2001, s. 44
[2] Tytyk E., *Projektowanie ergonomiczne*, PWN, Warszawa-Poznań 2001, s. 44
[3] Kamieńska-Żyła M., Ocena obciążenia fizycznego człowieka w procesie pracy, [w:] Ergonomia i ochrona pracy, Knapik S. (red.), Wydawnictwa AGH, Kraków 1996.

The paper raises an issue of warehouse workers' static load and its evaluation by means of OWAS method (*Ovako Working Posture Analysis System; Ovako Working Posture Analyzing System*).

It is an area significant to both operators and designers of labour conditions, ergonomics experts as well as logistics specialists using frequently imposed working conditions. The issue in question is insubstantially examined in Polish specialist literature, although it is crucial from health and work safety perspective.

1. INVENTORY CONTROL – WAREHOUSE PERSONNEL JOB DESCRIPTION

In each production enterprise we need to distinguish several fundamental logistic subsystems. One of them is inventory control. Its task is to handle and store goods in the field of supplies (materials reserves), production (numerous tasks in progress in interoperability buffers) and distribution area (distribution reserves).

The target of inventory control is to ensure optimal storage conditions under determined constraints of an enterprise. The objective of properly organized inventory control is also to guarantee appropriate functioning of other areas of enterprise business activity (e.g. production, sales, customer service, etc.).

Warehouse workers employed in an enterprise, considering the branch and responsibility, perform various functions such as[4]:

- warehouse keeper,
- inventory record keeper,
- storeman,
- warehouse auditor,
- storage facilities and warehouse traffic controller,
- mechanical storage facilities maintenance technician and stock,
- storage facilities operator.

Particularly interesting is the post of a warehouse keeper who is assigned to completion tasks, commonly in manual storage system. This system enforces raising, lifting, arranging, pushing, pulling, carrying, shifting, rolling of loads by one or more workers. Most warehouse operations are performed manually by a worker. In this system completion supervisor is responsible most of all for order picking, accurate arrangement and labelling of completed pallets.

His typical tasks and duties are for example:

- efficient performance of warehouse tasks according to safety rules and fire protection regulations, which guarantees optimal use of storage space,
- efficient transfer of completed unit loads in individual warehouse sections.

The equipment in contemporary warehouses is highly adapted to work in the system of storing and stocking of goods both in the form of unit loads (pallet or batch) as well as small dimension loads: individual, collective and transportive. Standard equipment in warehouses or storage areas adapted to manual work are steel racks.

Standard and modern steel racks are available on the market there. They allow correct and safe multistorey storage of goods. The racks used are up to 2m high (operated by a worker standing on the floor) and over 2m high (operated by a worker using platforms, travelling and hook ladders).

Internal transportation means also are satisfactory. While completing works most often used are non-powered trolleys: completion, platform trolleys, manual pallet jacks. They are driven by the power of human muscles.

The means of internal transport which are applied in manual storage system, have partially eliminated worker's dynamic load. Worker's muscles are still the energy source for completion of a particular technological task (pushing completion trolley, carrying, lifting of load, etc.). Regrettably, the tasks performed by a worker completing a pallet or a batch load in manual system also cause an increase in muscles static load (fig. 1). This means that during work a worker remains motionless but expends his energy as a result of sustained muscular tension.

2. OWAS METHOD

OWAS method allows to estimate the degree of a worker's static load at workstation by analyzing his posture. It is an analytical method which

[4] Dudziński Z., *Vademecum organizacji gospodarki magazynowej*, ODiDK, Gdańsk 2008, s.129-140.

enables the improvement of ergonomic conditions at a workstation. The method was developed in Finland by Ovako company. It takes into consideration various positions of the back, shoulders and legs. It also includes the weight lifted by a worker.

Each body position is encoded and categorized in four risk groups of static injuries. The method also requires the analysis of force exerted during work as well as the time of force influence in a defined position. OWAS method considers static load owing to:

- back position,
- forearms position,
- legs position and work,
- external load dimension.

Each of these factors has an attributed code value. On the basis of identified evaluation factors of the back, arms, legs position, and load one must determine position code. Each posture is defined by a four-digit code (fig. 2).

Sometimes there can be additional fifth element of the code which determines the head and neck position[5].

Identifying four-digit body position code with OWAS method allows to determine risk class of every workstation.

According to OWAS method and basing on the body position code there are four classes which reflect static load risk degree. They are presented in table 1.

Class 1 identifies body position as regular and natural; the load is optimal or acceptable. There is no need then to introduce changes to a workstation.

Class 2 encompasses potentially hazardous postures which may have negative effects. Static load is practically acceptable which indicates future assumption of certain means in order to improve working conditions as well as to change methods and manners of performing the job.

Class 3 points out a clearly hazardous influence of body posture, while static load is fairly large. Actions must be taken promptly which should improve working conditions and methods.

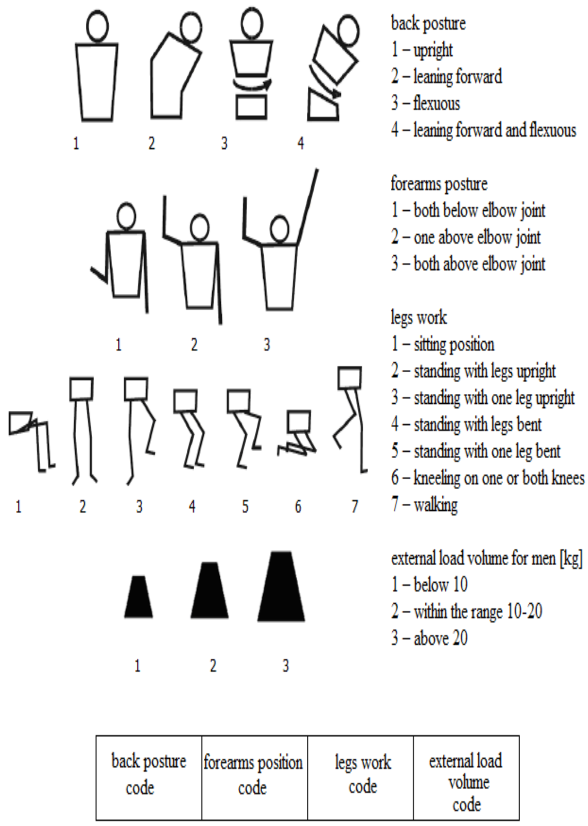


Figure 2. Determining body position code with OWAS method; Source: Keyserling W.M., *Postural analysis of the trunk and shoulders in simulated real time, Human Factors*, Ergonomics 29, 1986.

Class 4 encompasses postures and worker's body position which are defined as being considerably hazardous. Static load is also quite large. Immediate actions must be taken then to improve conditions and manner of technical equipment exploitation by a worker.

During an entire workday a worker carries out different tasks, assuming various positions. Typical day observation and estimating how often certain body postures are assumed by a worker will allow to evaluate static load risk degree proportional to the time spent in various body positions.

[5] Frei D., Analyse und Bewertung von Korperhaltungen bei der Forstarbeit mit Hilfe der OWAS-Methode, Wien 1996.

Table 1. Static load class; Source: Keyserling W.M., Postural analysis of the trunk and shoulders in simulated real time, Human Factors. Ergonomics, Nr 29, 1986.

Back	Load / ders	Legs 1	Legs 2	Legs 3	Legs 4	Legs 5	Legs 6	Legs 7

OWAS risk indicator can be determined by means of the following pattern:

$$OWAS = [(a \bullet 1) + (b \bullet 2) + (c \bullet 3) + (d \bullet 4)] \bullet 100$$

where:

- a – observation frequency percentage in risk class 1
- b – observation frequency percentage in risk class 2
- c – observation frequency percentage in risk class 3
- d – observation frequency percentage in risk class 4
- 1, 2, 3, 4 – the importance of individual classes of risk.

The values of OWAS received marker can be within the limits of 100% to 400%. Lower limit marker indicates that postural risk is minimal and the worker is not at risk of static load. When it approaches the upper limit it points out maximum risk of static load and immediate attempts to improve working conditions.

OWAS marker encompasses then the results of evaluation of various postures assumed by a worker in regard to the time. It assesses the influence of most hazardous postures assumed by a worker on his static load.

3. OWAS-BASED ASSESSMENT OF STATIC LOAD OF A WORKER PERFORMING COMPLETION TASKS – CASE STUDY

For the purpose of the paper, one labour day of a warehouse worker performing completion tasks was analysed. The case was conducted on the basis of private research. The analysis was carried out in a trading-production enterprise situated in Great Poland (the owner did not assent to including company's name in the paper). Enterprise premises comprise private finished-goods inventory and goods stock for further resale. Preparation as well as research and analysis were carried out in June 2009.

The scope of research encompassed two workers operating in a completion warehouse. The job of a warehouse worker in the enterprise mentioned consists in unpacking homogenous collective packs, taking individual items by completion list and reforming load unit of heterogenous structure. During completion working in hazardous positions occurs (leaning, flexure).

Completion is performed according to a principle 'man to article', i.e. on a means of internal transport and in designated completion points which are located at the lowest level of a warehouse.

Conducting completion by 'man to article' rule is the optimum solution to the case examined since a worker collects a relatively small amount of stock, however with a considerable range of assembled items.

OWAS method was combined with random observation method. The latter means observation of a single worker or a group at random in randomized moments of an entire working day. Preparation for research was based on determining:

1. observation time – 1 working day in typical warehouse conditions (no seasonal fluctuation, stratification or order deficiency, etc.), with time allocated for scheduled breaks,
2. types of worker's postures assumed during labour – so called fractions were allocated which refer to worker's body position during labour as well as each posture was assigned a code with hazard indicator,
3. essential number of observations – 100 planned,
4. observation moments of so called observation plan according to random numbers tables.

During one typical working day 100 observations were made concerning the evaluation of worker's posture with OWAS method. Four body positions were specified and assigned to various risk classes according to their code. During the observation worker's body position code was analysed and recorded in time intervals.

Observation, OWAS code and risk class are comprised in table 2.

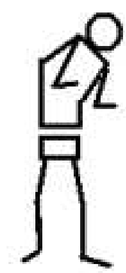
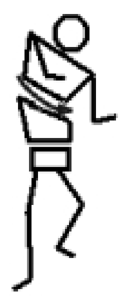
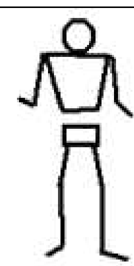
OWAS risk index was also determined which figured 241%.

$$[(19 \bullet 1)+(32 \bullet 2)+(19 \bullet 2)+(30 \bullet 4)] \bullet 100 = 241$$

In order to reduce static load risk, minimize muscular and spinal discomforts, one must constantly monitor and optimize worker's posture during labour. If working in one position exceeds 30% of a work shift it creates with most workers the risk of fatigue and health problems. The case study revealed that during typical tasks a worker spends 32% of his time in a position which can have negative effects, while the static load is practically acceptable.

He also spends 30% of working time in highly hazardous position with a high degree of static load. Therefore immediate actions must be taken to improve working conditions as well as the manner of technical equipment exploitation. Worker's body position is significantly uncomfortable since it imposes a considerable trunk inclination and flexure.

Table 2. Static load class

No.	Worker's body posture	OWAS code	Class risk	Number of observations	Percentage of all remarks
1		2121	2	32	32%
2		4131	2	19	19%
3		4141	4	30	30%
4		1121	1	19	19%

However, the job is performed in a relaxed manner and a worker can allow himself a short break to change his body position. The job does not require a lot of energy either. These are the factors which minimize the negative influence of body position in code 2121 and 4141. Workers performing completion jobs in a warehouse should be referred to a training on safe realization of manual completion tasks.

The company's owner should also make necessary investments to replace previous technical equipment with more ergonomic one, facilitating work and eliminating negative body position.

4. CONCLUSION

OWAS method allows to conduct, in a standardized manner, the evaluation of postural ergonomics and a consequential worker's static load[6]. Undoubtedly good points of the method are its simplicity and comprehensiveness. It enables the analysis of body postures assumed by a worker.

What is also significant is the possibility to determine recommendations for corrective and repair actions, not only to identify a problem. On the basis of the method it is possible to perform actions to correct manners and methods of work, to improve working conditions and to properly adjust implements, appliances and machinery to ergonomics directives.

The method can be applied to various production and service areas which is acknowledged through research results published in professional literature. The authors of '*Analysis of problematic working postures and manual lifting in building tasks*' M. Mattila i P. Kivi applied the method to evaluate static load of workers employed on twelve different workstations at a construction site[7]; M. Vilkki and others conducted research on evaluating static load of production workers[8], while J.A. Engels and others engaged in the estimation of static workload among nurses[9]. The method was also applied to assess workers employed to cultivate medicinal and textile plants[10].

The research presented in the paper points out that OWAS method can be applied to evaluate workloads of employed staff during warehouse jobs in manual system of storage and completion.

By means of OWAS method, the conducted analysis of a warehouse worker pointed out that work is marked with static load risk. A comprehensive analysis of body position and job organization is required. Technical equipment should also be analysed. Probable means to eliminate work risk is to change a standard completion trolley for the one which allows to lift the load bearing part so that it eliminates the necessity to lean.

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