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Focus on the human being: Cognitive Ergonomics in intralogistics

Der Mensch im Fokus: Kognitive Ergonomie in der Intralogistik

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The role of logistics industry is gaining continually in importance due to increasing globalisation and flexibilisation of labour market. Furthermore, new organisational structures and new information and communication technologies emerge accompanied by rising dynamization, automation and digitization of the working world. As a result of modern requirements in logistics, especially the intralogistics sector is increasingly becoming a focus of interest.

[Cognitive ergonomics, order picking technologies, workload, information processing, human-machine interaction]

Die Logistikbranche gewinnt infolge der wachsenden Globalisierung und Flexibilisierung des Arbeitsmarktes zunehmend an Bedeutung. Infolge der Dynamisierung, Automatisierung und Digitalisierung der Arbeitswelt finden neue Organisationsstrukturen und neue Informations- und Kommunikationstechnologien ihre Verbreitung. Einhergehend mit den modernen Anforderungen an die Logistik steht insbesondere die Intralogistikbranche verstärkt im Interessensfokus.

[Kognitive Ergonomie, Kommissioniertechnologien, Arbeitsbeanspruchung, Informationsverarbeitung, Mensch-Maschine-Interaktion]

1 THE CHANGING WORKING ENVIRONMENT

Against the background of rising flexibilisation of labour markets, since the end of the 20th century job demands have changed noticeably [Loh12]. Furthermore, prevention of psychological stress at the workplace becomes increasingly important. A current, representative survey of employed persons – the BIBB/BAUA Workers' Survey – clarifies the risk of mental workloads [Bun12]. More than half of employees often works under great deadline and performance pressure [Kre15]. Regarding physical or environmental working conditions various types of loads have decreased markedly in recent years and stabilised at a relatively high level [Loh12]. Nevertheless, physical or psychological work-related risks are still rarely recorded or documented in companies in Germany [NAK17]. Besides legal requirements, it should be a general objective to preserve safety, health and thus work ability of employees in the longterm [BB14, NAK17].

2 FREQUENT WORK DEMANDS IN THE INTRALOGISTICS

In line with growing globalisation the intralogistics sector has increasingly gained in importance since the past years [Bun15, MM06]. The increase in goods handling at the decisive international logistics nodes is basically driven by globalisation. High requirements in logistics can be recognised such as a growing diversity of product variations, acceleration of product cycles and customers' high performance and service expectations [MM06]. In the course of the saturation of the German logistics market, main focus is placed on efficiency enhancements or increasing professionalisation. In particular, in the intralogistics sector a high flexibility is required to meet customer needs [RW08]. Due to changing working environment, new forms of organisation, information and communication technologies, and a rising level of automation in the field of intralogistics are more and more disseminated [KSR16]. For companies it is a particular challenge to integrate employees into complex and steadily changing work environments. Despite of increasing mechanisation within the field of intralogistics, employees are still confronted with physical job demands, they still transport, store, pick, sort or distribute economic goods [Gün06].

In the following, based on the BIBB/BAuA Workers' Survey 2012, frequent physical and mental job demands and work-environment conditions of warehouse workers are reported [Bun12]. Professional activities in the intralogistics sector are classified using the Standard Classification of Occupations 2010 [Bun11]. Unskilled, middle-skilled and high-skilled jobs are summarised. In the warehouse logistics, majority of employees is male, working fulltime, middle-aged and has a weekly working time of 40 to 47 hours [Kre17]. Regarding environmental working conditions (Fig. 1 [Kre17]) warehouse workers often wear protective clothing or safety equipment (46,4 %), work under unfavourable climatic conditions such as cold, heat, wetness, moisture or draught (33,1 %), are exposed to noise

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(26,0 %) or dust, smoke, gases or vapours (17,4 %). With respect to physical job demands (Fig. 2 [Kre17]), employees in intralogistics frequently work while standing (80,5 %), work with hands (56,4 %), lift and carry heavy loads (46,3 %) and work in forced postures (21,5 %). Concerning psychological job demands (Fig. 3 [Kre17]), almost three-quarter of warehouse workers often report monotonous work processes (72,9 %). Furthermore, high work intensity is also widespread in intralogistics:

Nearly half of the employees state that they often have a high pace of work (47,0 %) or great deadline and performance pressure (45,5 %). In addition, frequently reported mental working conditions are multitasking (38,7 %), disruptions and interruptions during work (37,2 %) or a limited scope of action such as prescribed work processes (39,3 %) or prescribed quantities, performance or time (30,8 %). Besides, more than one fifth often works at the limits of capability (21,7 %).

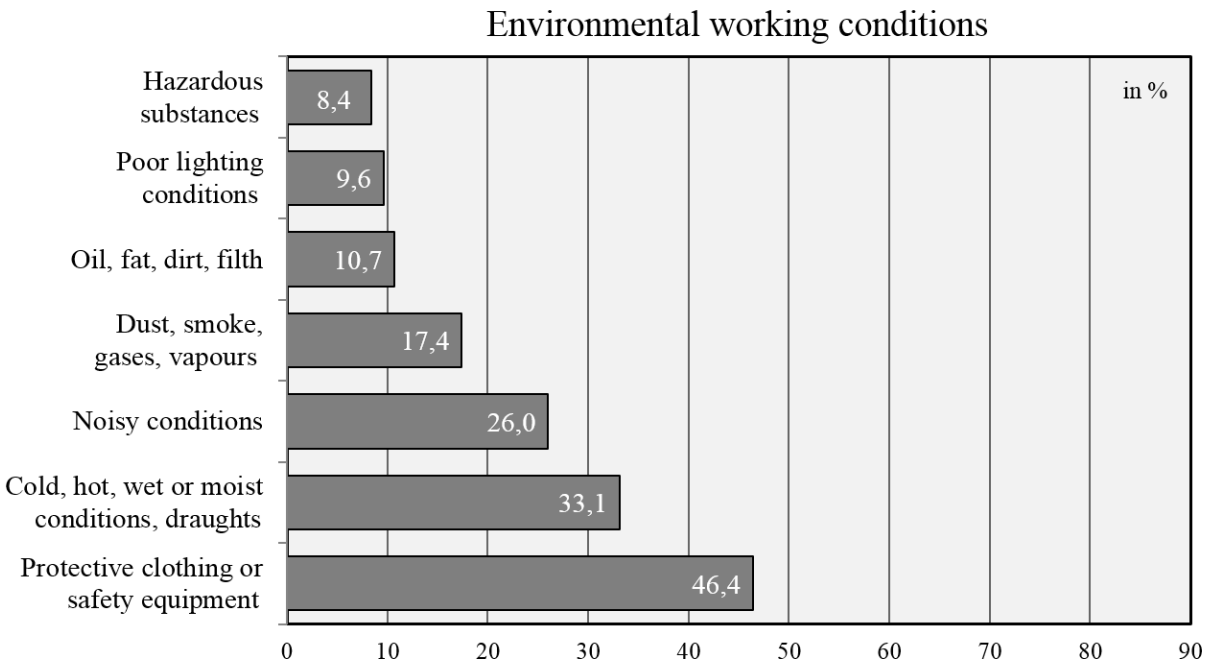

Figure 1. Frequently reported work environment conditions of employees in the warehouse industry (%) [Bun12, KBSR17, Kre17]

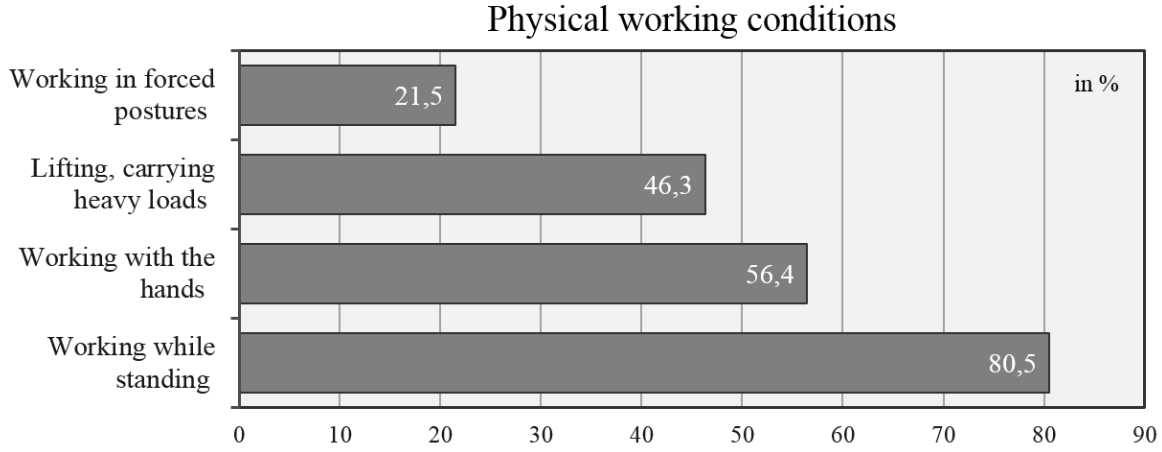

Figure 2. Physically demanding working conditions reported frequently by employees in the warehouse industry (%) [Bun12, KBSR17, Kre17]

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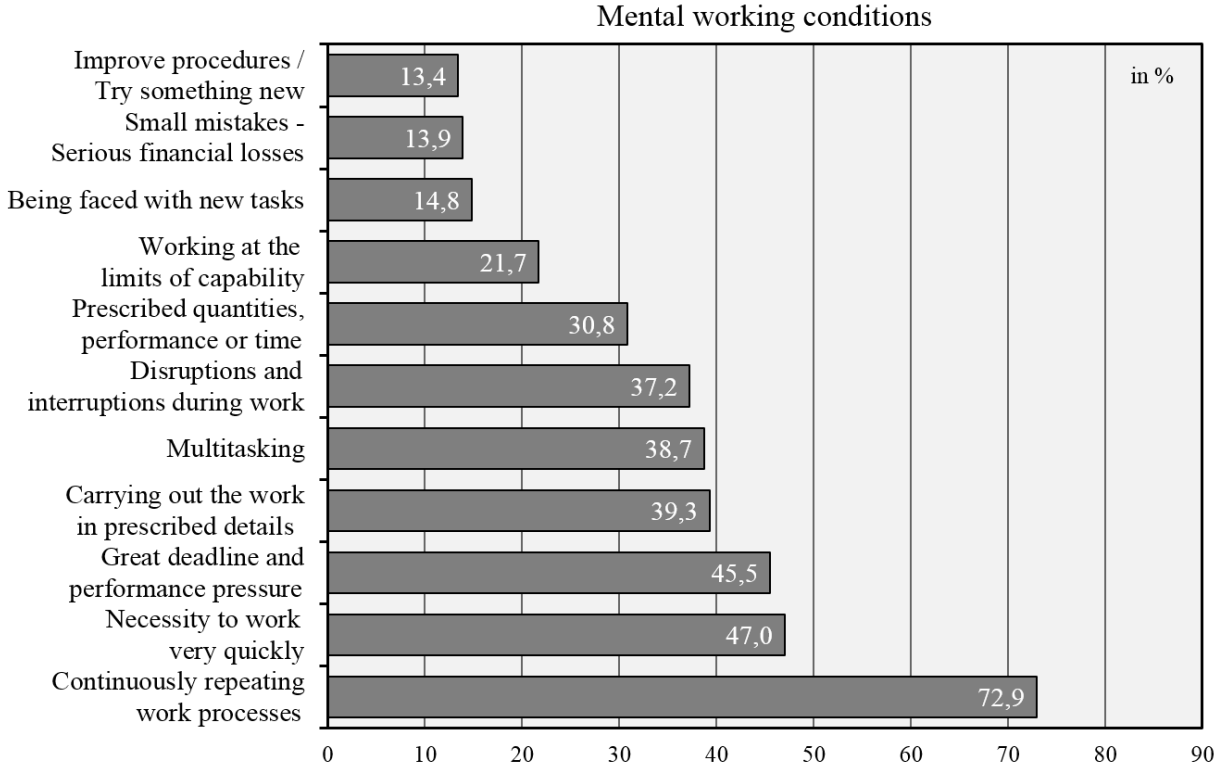

Figure 3. Frequently reported mental working conditions of employees in the warehouse industry (%) [Bun12, KBSR17, Kre17]

Summarising, results of BIBB/BAUA Workers' Survey 2012 imply that employees in the intralogistics sector are exposed to various physical and psychological job demands and environmental working conditions. Nowadays, there are still typical physical work conditions such as working while standing, manual activities or heavy lifting and carrying. Regarding mental work demands, warehouse workers are faced with a great variety of requirements. It can be supposed that in times of digitalisation new forms of workloads will emerge. The usage of technical assistance systems for information processing and exchange at an individual level will lead to changed mental and especially cognitive demands. With respect to human-technology interaction, new work demands and interactions of various strains will arise.

3 RESEARCH FIELD »COGNITIVE ERGONOMICS«

Regarding the national joint research project »Centre of Excellence for Logistics and IT«, the unit Intralogistics and IT Planning of the Fraunhofer Institute for Material Flow and Logistics (IML) investigates the research field of »Cognitive Ergonomics«, together with the department of Ergonomics of the Leibniz Research Centre for Working Environment and Human Factors at TU Dortmund (IfADo). The proposed objective of the »Centre of Excellence for Logistics and IT« is to extend existing research and development centre for logistics and IT in Dortmund in collaboration with external partners from science and business.

»Cognitive Ergonomics« is one subsection in the research field of ergonomics regarding human-machine interface (Fig. 4).

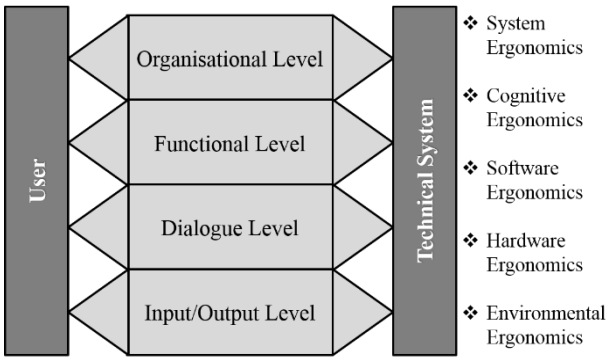

Figure 4. Different levels of human-machine interface and relevant subsections of ergonomics [Kra86]

Within the research topic of »Cognitive Ergonomics«, the focus lies on order picking which is an important process and a central function within intralogistics [GGN17, RW08]. The manually performed process of order picking is one section that largely depends on employees work performance. Thus, facing this intralogistic scenario, largest

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range of influencing factors can be collected and considered. In the course of digitisation, the widespread classic manual method of the paper-based picking list will be replaced by new technological assistance systems in the long run. Thus, the handling of various order picking technologies such as pick-by-voice, pick-by-light or pick-by-vision and associated cognitive demands is investigated empirically in field and laboratory studies.

Besides, a wide range of psychological and physical workloads of order picking workplaces are explored comprehensively. Based on this detailed risk assessment, a stress and strain model is to be developed and validated to continuously capture work demands of order pickers in real time. For longterm purposes, human-machine interaction and intralogistic work systems in general will be optimised to preserve work ability, work performance and health of order pickers. In addition, by optimising the order picking system, operator errors and therefore financial losses can be reduced in the long term. Thus, delivery quality and finally customer satisfaction, customer loyalty and business confidence may be improved [RGG12, RW08]. The pursued aim of »Cognitive Ergonomics« is to establish smart working environments that create the basis of monitoring, evaluating and optimising mental and physical workloads of employees.

4 Research methods

It is a fact that there is a great need of research regarding the role of the human being within warehouse order picking [GGN17]. Thus, the first step within the research project »Cognitive Ergonomics« is a comprehensive literature research with respect to the impact of different order picking technologies on mental and physical workload, usability and objective performance indicators. Furthermore, both field and laboratory studies are conducted. The following list gives an overview of research methods to be carried out ([KBSR17, KESR17]):

- Psychometric instruments (e.g. psychosocial job characteristics [NSHMH05], mental load dealing with various order picking technologies [HS88])
- Ergonomic analyses (e.g. physical working conditions [Bun01, Bun02], environmental working conditions)
- Psychophysiological measurements (e.g. heart rate variability, brain activity)
- Company key figures (e.g. picking times, error rate)

5 Summary and outlook

Despite of the advancing automatisation, digitisation and mechanisation of warehousing, order picking processes will continue to be manual activities performed by human order pickers. Especially in future intralogistic working environments, heterogeneous and rapidly changing product portfolios require a flexible and adapting way of working that still is a unique characteristic of the human being.

Along with new information and communication technologies or technical assistant systems within the field of intralogistics, job enlargement of order pickers will be apparent. In addition to already existing physical and mental workloads, new job demands arise regarding human-machine interaction such as monitoring, evaluating or controlling digital processes. With respect to the research project »Cognitive Ergonomics«, a practical gain of knowledge is focused to design applied technical assistance systems or user interfaces human centred in future. As employees in intralogistics will not be substitutable by new technologies in the near future, order pickers should be supported as effectively as possible by smart assistance systems or smart work environments.

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