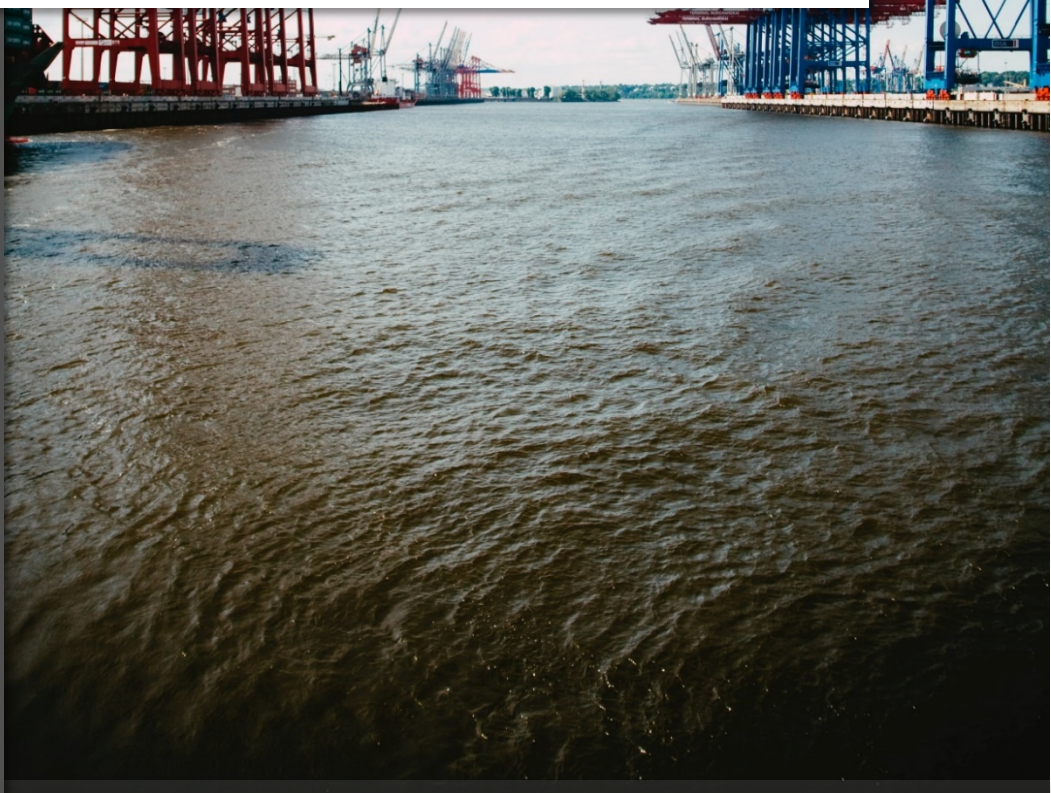


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Preventing Mental Strain for Logistics Workers: Guideline Development



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Purpose: The purpose of this paper is to discuss and analyze the introduction of a guideline, which aims to help prevent mental strain for logistics workers in an increasingly digitalized work environment. The guideline originates from the findings of computer science experimental rooms (IR) and expert workshops, which were analyzed in three German companies and are part of the INQA-project DIAMANT as well as from literature findings.

Methodology: Mental strain and stress are identified from interviews and questionnaires in three experimental rooms as well as from literature review (and discussions with the logistics workforce of the German companies). The identified factors are then translated into a guideline with recommendations for reaching and maintaining a healthy digitalized work environment in logistics.

Findings: The guideline “Case Studies Digitalization” shows the (interim) results of the three experimental rooms of the INQA-project DIAMANT. This paper offers insights regarding certain elements of the guideline and how the different recommendations were created.

Originality: The paper provides interesting insights into the development process of a guideline that focuses on requirements for healthy digitalized work in logistics. Along with these requirements, the challenges today’s logistics workforce faces in a quickly changing work environment are exposed.

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1 Introduction

In the context of an ever-increasing level of digitalization in logistics, sick days due to mental health issues are on the rise (Knieps and Pfaff, 2019, p. 146). The growing digitalization has changed the work environment, and job strain is transforming from physical to psychological strain (Kadir et al., 2019; Lang et al., 2019). These changes include, for example, converting work hours, higher complexity and responsibility, as well as, rising job demands that lead to excessive demand or concentration disorders (Grosse et al., 2017). Furthermore, the implementation of new technologies is associated with a higher work intensity (Böckelmann and Seibt, 2011, pp. 207, 210-211; Meyer, Tisch, and Hünefeld, 2019, p. 219). Additionally, the potential perceived data overload and extended availability might block creativity and lead to increased stress, boundary-blurring and reduce the ability to enter mental relaxing phases (Nöhammer and Stichelberger, 2019, p. 1192). Therefore, the question arises how to prevent mental strain in (logistics) workers and sustain a healthy and motivated workforce. This paper will share advanced insights into the INQA-project DIAMANT to show the (interim) results of three experimental rooms. After the project and the purpose of the guideline are introduced in section 1, a literature review (section 2) on mental strain and increasing digitalization (in logistics) is going to give insights on the challenges for mental health that come along with an increasing level of digitalization. The development considerations for the guideline are introduced in section 3. In section 4 project findings will then support and underline the literature findings and lead to the content of the guideline. Section 5 and 6 show the limitations and implications of this paper, as well as a conclusion and an outlook.

The INQA-project DIAMANT tries to answer the question of how the rising digital working world can be innovatively organized and designed to gain advantages for companies and workers. Therefore three German companies are accompanied in their journey of digitalizing their work processes and evaluating mental challenges their workforce faces in a more and more digitalized work environment. During the project, an E-Coaching-System is developed and implemented to further support workers in their skills development. On top of that, the project team is also going to develop and implement a digital-ideas-management-software with the companies to help accumulate ideas of workers in a standardized way and reach continuous improvement. The three companies operate in the fields of retail, logistics, and production and thus provide a diverse background (online information at: diamant.digital).

2 Literature Review on Mental Strain and Increasing Digitalization in Logistics

Mental strain is defined as the “Entirety of all detectable influences that psychologically impacts humans from the outside”. It includes positive as well as negative emotional and behavioral requirements (Böckelmann and Seibt, 2011, p. 209; Deutsches Institut für Normung e.V., 2015, p. 9). Positive stress is given when a person is in a challenging situation but is confident to successfully master the task or situation. Negative stress, in contrast, is present when a person is in a situation where he or she is unable to succeed. Positive stress can lead to adrenaline kicks and feelings of success, whereas negative stress often leads to anxiety, muscle tension, high blood pressure and weakened capacity to recover (Berlin and Adams, 2017, p. 111).

The implementation of Industry 4.0 concepts, in general, causes a lot of change in today’s work environments. Communication between users and Cyber Physical Systems (CPS) leads to higher importance and interaction of human-machine-interfaces (Dombrowski and Wagner, 2014, p. 102). Industry 4.0, however, has to be distinguished from Logistics 4.0 or the increasing digitalization in logistics. Industry 4.0 applications deal, for example, with intelligent machine-user-interfaces, digital visualizations of machine or production conditions, or remote-maintenance of machines. Many of these applications have their routes in production processes and have no certain relevance for logistics processes. Logistics 4.0, in contrast, deals with telematics-applications, integrated freight exchanges, intelligent containers, or autonomous vehicles. Industry 4.0 and Logistics 4.0 still have the combined aim to optimize material flows through digital- or information-

networking (Bousonville, 2017, pp. 13-14). The increasing use of new technologies comes along with new tasks and expectations towards logistics workers. As work tasks get more complex and autonomous, the demand for cognitive and communication skills grows. Workers change from executors to evaluators (Klumpp et al., 2019a, p. 72). These changing demands in Industry/Logistics 4.0 lead to higher psychological job demands.

Mayerl et al. analyzed the relationship of psychological job demand and mental strain through two surveys. In their research, they described mental strain to consist of three constructs: Irritation, exhaustion, and alienation. Their research confirmed that high psychological job demands resulted in higher levels of mental strain, which is associated with poor health (Mayerl et al., 2016, pp. 1, 5). Back in 1979, Karasek already described the connection of job demands, job decision latitude, and mental strain. He found out that lower work demands are associated with increased satisfaction. However, in combination with low decision latitude, low work demands would lead to a higher risk of mental health problems. His conclusion was that by increasing decision latitude, job strain could be reduced, regardless of changes in workload demands (Karasek, 1979, pp. 302-304; Meyer, Tisch and Hünefeld, 2019, pp. 208-209).

In the past years, there have often been concerns that the growing digitalization may result in future job loss due to automation (Arntz, Gregory and Zierahn, 2016, p. 4). Furthermore, in their research on workplace changes, Nikolova et al. found out that qualitative job insecurity due to workplace changes leads to emotional exhaustion (Nikolova et al., 2019, p. 14). These findings could lead to additional mental strain in workplaces due to perceived job insecurity through workplace changes and rising automation.

Various studies have recently dealt with possible job losses due to automation and have come to a wide variety of results. In their famous 2013 study, Frey and Osborne estimated that about 47% of total US employment is at high risk (>70%) of being automatable perhaps over the next one or two decades (Frey and Osborne, 2013, pp. 37-38). Arntz, Gregory, and Zierahn, however, determined that only nine percent of jobs in OECD countries (nine percent is also the figure for the US) are at high risk (>70%) of being substituted due to automation in an analysis across 21 OECD countries. The risk ranges from six percent in Korea to twelve percent in Austria and Germany (Arntz, Gregory and Zierahn, 2016, pp. 8, 15-16). Dengler and Matthes (2019) furthermore evaluated that the risk of automation is not the only important factor when considering potential job loss. They state that even though the share of jobs at high risk is rising, the substitution potential cannot directly be translated into job loss potential. Even though the substitution potential is high for logistics jobs, the possibility of job loss remains low due to ethical hurdles, higher profitability, flexibility, or better quality of human operators (Dengler and Matthes, 2019, p. 56). Koleva and Andreev (2018) additionally stated that the workers' role in an industry 4.0 (or in this case logistics 4.0) environment should not be underestimated as the technology should not be seen as a threat and substitute but as a helping hand. Due to automation, employees can focus on operations that bring bigger added value and do not have to cope with routine tasks (Koleva and Andreev, 2018, p. 2). Even though that the risk of automation may be high, managers could communicate the stated advantages of human operators and the lower association with real job loss to their workforce to prevent mental strain due to perceived job insecurity.

Though there seems to be a growing interest, discussion and understanding of the negative aspects of digitalization for managers and workers in recent literature, there seems to be a research gap regarding easy-to-follow advice to promote mental health and evaluate mental strain in a growing digitalized working environment. This is important for research and management to know as such guideline knowledge regarding digital implementation issues could lower the hurdle for firms and workers alike to enter digitalization projects. This paper therefore analyzes and accumulates recommendations on healthy digitalized work and tries to enable decision makers to easier address this topic as an example of how to arrive at such relevant change management process knowledge for digital logistics.

3 Creating a Guideline on Healthy Digitalized Work in Logistics

Especially firms and logistics managers require easy-to-use methods and materials to enhance the workers' health protection, and mitigation of health risks as this is not the focus of many decision perspectives. Though there is a number of law regulations prohibiting too much also mentally exhausting work, evaluation and assessment are not high on the most corporate priority lists. Therefore, a time-saving approach is required to support fast decisions and checking for specific workplaces and digital logistics work areas. This guideline, therefore, provides managers and other persons in charge with easy-to-use advice.

3.1 Methodology

To generate recommendations and requirements for a healthy digitalized work environment, the project findings and relevant literature are analyzed. The results will include positive findings as well as negative findings, which were transformed into recommendations. The findings and so the future contents of the guideline are then combined and presented in a shortened form. The literature research focuses on studies and papers that recommend certain practices to promote mental health and avoid mental strain in the workplace. This includes general as well as specific findings. The project findings originate in large part from risk assessments and interviews, which were performed in the three companies.

The databases which were used for the literature review are the EBSCO database, SpringerLink and Google Scholar. The main search terms were:

Mental strain, industry 4.0, logistics 4.0, mental stress, digitalization, scrum, design thinking, cobot, healthy digitalized work and mental health promotion. The findings also originate from interviews which were conducted in the partner companies of the DIAMANT project in 2019 and 2020. In these interviews, workers were asked about their mental health status, their decision latitude, the organizational climate and mental stress and strain through as well as the acceptance of new technologies.

For the development of the guideline content, a design thinking approach was used in order to better understand what is required to prevent mental strain and reach a healthy digitalized work environment. The design thinking approach prescribes a human/user-centered innovation process (Bicen and Gudigantala, 2019, p.10; Becker et al., 2020, p. 279). Innovators are guided on a personal journey that transforms their minds from that of experts to that of users building emotional commitment and allowing them to see and share new possibilities. After rearranging their mindset, they come together in dialogue-based conversations to reach alignment in what matters most from a user perspective. In a hypothesis-driven method, critical assumptions behind the newfound ideas are evaluated and visualized through various design tools. After all, they are implemented in experiments and tested in action. Through design thinking, innovators adopt the perspective of the end-user and can understand the needs, which are valuable to it. In gaining insights into the minds of those, being designed for the innovator builds emotional commitment and is able to bring in better higher order solutions into the discussions. In the experimentation and visualization phases, the innovator gains feedback from users and confidence in which solutions work best (Liedtka, 2020, pp. 55-57).

Another important methodology in the development process was a scrum. According to Gloger and Margetich (2018), a scrum does not break down the development process but the product. The overall project is split into mini-projects called sprints. These sprints have a maximum duration of four weeks. During a sprint, there are scheduled review sessions, and feedback of customers is used to continuously develop the product. A scrum ideally consists of seven persons with the following roles: the scrum-master, the product owner, and a development team of five. These cross-functional teams work according to the pull-principle and are responsible for how much work they plan to do in a determined period. After every sprint, the team has to present solutions to the determined sprint-tasks. The three roles have the following tasks during a scrum:

The development team: Delivering the product in the specified quality and under the circumstances of the agreed standards and processes.

The product owner: Working with and directing the development team. He or she has the vision and responsibility that the team develops the appointed functions.

The scrum-master: Helping the team reach its goals. He or she assists the team at reaching their goals, helps to solve problems, and trains them to understand and fulfill their roles (Gloger and Margetich, 2018, pp. 61-62).

This method is mostly used in product and software development but can be adapted to almost any field and is especially suitable for projects and teams in complex environments. Additionally, to the three roles in a scrum, there are four formally prescribed events: sprint planning, the daily scrum, sprint review, and sprint retrospective. During the sprint planning, the whole team is discussing and setting a sprint goal that can realistically be

reached and has to be considered in every step. The daily scrum is a daily 15-minute meeting of the development team to synchronize activities and develop a plan for the next 24 hours. After the completion of a sprint, a sprint review with the scrum team and invited stakeholders is held. An evaluation of what has been achieved during the sprint is made, and work that is required to finish the sprint in the given time frame is identified. The last event is the sprint retrospective, which is held after the completion of one and before the start of another sprint. The focus during this event lies on analyzing the last sprint and developing a plan to improve the working procedures for the next sprint (Gonçalves, 2018, pp. 40-42).

3.2 Target Group

This paper and the resulting guideline are created to support companies and researchers in all fields and sizes of institutions and companies regarding digitalization changeovers. There is, however, a focus on companies in retail, logistics, and production due to the fields of action of the project partners. Due to the diverse background of the three companies, the literature findings, and the researchers, the results should still be applicable to various sectors that are dealing with a growing digitalized work environment. There seems to be a need for easy-to-follow advice in companies dealing with change connected to digitalization. Processes are shifting from Computer Integrated Manufacturing to the combination of automated processes and manual tasks (performed through humans) in hybrid systems. Executive production tasks are decreasing, and future work tasks require comprehensive process thinking and self-organization (Dombrowski and Wagner, 2014, p. 102). Another important development regarding hybrid systems is the implementation of collaborative robots

(cobots) into work systems. Cobots combine a robot's strength and repetitive performance with the ability and skills of humans (Syberfeldt and Ekblom, 2019, p. 108). Therefore, the cobot cooperates with humans and is easily accessible for a human operator. It also contains integrated safety features and sensors to protect human operators when they get too close or in the motion of the cobot (Poór, Basl and Broum, 2019, p. 43). These hybrid systems demand different mental challenges for the human operator, and therefore, the content of this paper is also relevant for workers in that kind of systems.

3.3 Development Considerations

To gain superior ideas, solutions, and recommendations for the guideline, the design thinking method that was described in 3.1 was implemented and adjusted to the special conditions of the DIAMANT project. Some elements of the scrum-approach were also implemented, but the physical distance of the project team made it easier to stick more to the design thinking approach. To adopt the mindset of the workers (who are the end-users in this case), the researchers held several discussions and workshops with them in order to understand what the specific problems and needs were and where they originated. Doing so also resulted in an emotional commitment to try to reach better work conditions for the workers. The gathered solutions that were visualized and implemented are now in an experimentation phase. After wrapping up this phase, feedback will be collected to optimize and further personalize the solutions in the different companies. This last step will be covered in further literature after the DIAMANT project has fin-

ished. Beckman and Barry (2007) visualized this innovation process of problem and solution finding and selecting in their work on embedded design thinking. Figure 1 is based on their visualization and was modified according to the needs of the DIAMANT project.

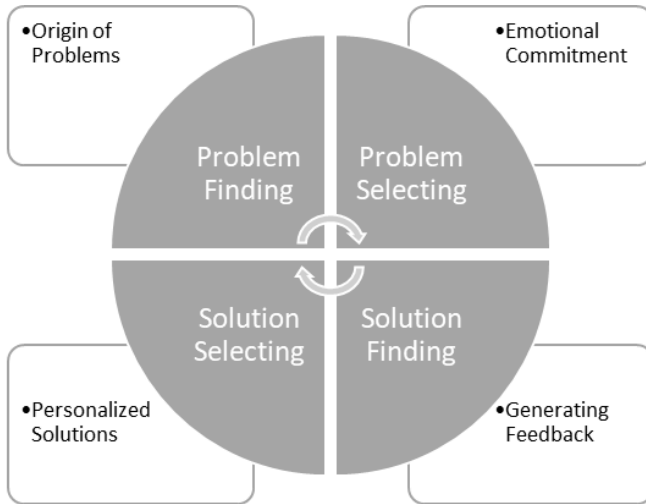


Figure 1: The Innovation Process as Problem and Solution Finding and Selecting (Based on: Beckman and Barry, 2007, p. 44).

4 Requirements and Recommendations for a Healthy Digitalized Work Environment

In this section, specific requirements and recommendations from the project and literature findings are presented. After the presentation, the resulting content of the guideline is introduced, and further ideas for the guideline will be discussed. The literature findings originate from various studies on mental health, mental strain, and work performance. General implications for mental health promotion are shown as well as more specialized implications for digitalized work environments.

4.1 Literature Findings

In regards to general mental health promotion, Seaton et al. (2019) analyzed mental health promotion in Canadian male-dominated workplaces through consultations and interviews and came up with suggestions to strengthen mental well-being in these workplaces. Four themes emerged, which should be promoted as follows:

- (a) Reduce stigma through addressing misinformation, providing information on mental illnesses like depression, and showing the importance of mental health for workplace safety.
- (b) Build social cohesion in supporting a culture of “having each other`s backs”. This is also achieved by promoting fun group activities in the workplace.
- (c) Foster enjoyable activities that are supported by the top of the organization (like going bowling as a team in the afternoon).

(d) Support mental well-being through a consistent and ongoing focus on wellness and regular events. It is more important what happens on a day-to-day or week-to-week basis than what happens once or twice a year (Seaton et al., 2019, pp. 546-548).

Even though these findings should promote mental health in men-dominated workplaces, they can be viewed as general advice to promote mental well-being in every workplace.

In their work to support optimal human performance, Berlin and Adams (2017) referred to the following, more precise, advice for cognitive support and a healthy digitalized work environment:

- (a) Provide good lighting, minimize noise, use haptic signals, and provide redundancy in sensory stimuli.
- (b) Minimize the need for keeping too much information in the short-term memory.
- (c) Aid perception using visual cues, pattern recognition, and consistency in design.
- (d) Avoid information overload and use standardized work.
- (e) Provide each workstation with work instructions.
- (f) Use poka yoke methods; pick by light or voice, or andon.
- (g) Simplify product designs to aid assemblers.
- (h) Minimize the occurrence and effects of negative stress.
- (i) Provide support for workers to handle stress – consider the cognitive needs of the individual.
- (j) Strive to match the levels of control, demands, decision latitude, support, and supervision to the individual's skill, experience, and maturity to allow workers to make their own decisions.

(k) Use design models at different stages of the design process to stimulate the workers to discuss and give ideas – this fosters solution ownership, innovation, and acceptance (Berlin and Adams, 2017, p. 266).

Mayerl et al. (2016) stated similar conclusions to promote mental health and prevent mental strain. They suggested three things as most important: (1) Fight overwhelmingly psychosocial job demands, (2) Reduce symptoms of mental strain through interventions, including strategies for cognitive behavior or relaxation techniques, and (3) Enlarge resources through the improvement of labor conditions and the strengthening of physical, mental, and social resources (Mayerl et al., 2016, p. 9). Böckelmann and Seibt (2011) support these findings but get a little more specific. According to their conclusions, optimization of psychological strain, health promotion, and growth of resources can be achieved through (1) Optimization of working conditions, design, organization, diversity, decision latitude, qualification potential, and coping strategies. (2) Professional and emotional support through colleagues and supervisors, and (3) Promotion of workers' competencies through professional and social qualification, cognitive control conviction, positive self-instruction, and personal relaxing techniques (Böckelmann and Seibt, 2011, p. 218).

4.2 Project Findings

Findings of the first stages of the DIAMANT project and an expert-workshop have shown similar results and recommendations on a healthy digitalized work environment. This has accomplished a detailed expectation and challenges analysis in the status quo. As a next step, digitalization changeovers

in experimental settings will be implemented on the basis of this knowledge. The most common problems that occurred were that:

- (a) Digitalization was often only referred to as avoiding and reducing the use of paper.
- (b) The given hardware was limited to computers, smartphones, and scanners.
- (c) The rising use of technical solutions increased strain through: growing time pressure, the complexity of a task surpassing the skill level, continuous reachability, using inflexible and unapproved technical solutions, and a higher possibility of being controlled through others.
- (d) Learning demands were regarded as too high, and that could result in a refusal due to cognitive overload.

Positive findings of the project that have been collected so far are:

- (a) Workers view it as positive when they are involved in the development of technical processes.
- (b) They view rising digitalization as a risk reducer through the reduction of errors due to the use of technical assistant systems.
- (c) Modern and better hardware is viewed as a sign of appreciation.
- (d) Technical visualization is associated with simplifying work tasks.

The following things are seen as critical factors for a successful digitalization: (1) Performing a detailed analysis of requirements and involved processes and persons, (2) Ensuring an open communication of all steps with all persons involved, (3) Granting enough time for training and implementation that also results in higher acceptance rates, (4) Providing early communication of the positive aspects of the digitalized-option and appreciation and praise in case of successful implementation and use (Klumpp et al., 2019a, pp. 76-78; Klumpp et al., 2019b, p. 3694).

4.3 Guideline Content

The structure and content of the guideline have been made up of the literature and project findings. In the introduction, four fundamental questions are answered: (1) What is the purpose of this guideline?, (2) Who is this guideline dedicated to?, (3) Which themes are covered in this guideline?, and (4) Who are the authors of this guideline?

In summarizing the literature and project findings the following themes, advice and practices to prevent mental strain and support mental health have been determined as most important:

(a) Layout important information that supports mental health at the workplace/work station through:

- (1) Providing general information material on mental illness, mental health, and mental well-being.
- (2) Providing detailed work instructions at every workplace.
- (3) Providing workers with positive self-instruction, relaxing techniques, and information on how to deal with and fight against the occurrence of negative stress.

(b) Optimize the workplace/work station design to support mental health through:

- (1) Providing good lighting, minimizing noise, and working with haptic signals.
- (2) Using visual cues, pattern recognition, consistent and simplified design, and standardized work.
- (3) Using poka yoke, pick by light/voice or andon.

- (4) Providing needed and state-of-the-art hard- and software and technical assistant systems to support technical visualization and simplifying work tasks.
- (c) Train and promote cohesion and individual strengths and work on weaknesses and needs through:
- (1) Building social cohesion and supporting fun group activities in the workplace.
 - (2) Fostering enjoyable activities outside of work with the support of the top of the organization.
 - (3) Consistent and ongoing focus on wellness and regular events.
 - (4) Providing support to handle negative stress (e.g., coping strategies and relaxing techniques) while considering individual cognitive needs.
 - (5) Matching a workers skill/experience/maturity to the level of control and trying to increase workers' decision latitude in general.
- (d) Holistic involvement of workers through:
- (1) Involving workers in every phase of the planning and implementation of technical processes and using design models to stimulate workers, support discussion, and increase acceptance.
 - (2) Supporting an open communication of all steps with all persons involved in the process.
 - (3) Communicating the positive aspects of digitalized options, appreciate, and praise them after a successful implementation.

5 Limitations and Implications

Even though the analysis of factors for a healthy digitalized work environment considered the results of the DIAMANT project and contains a wide variety of literature, it is important to state that not all advice and requirements have been tested during the project yet. However, the ones that were not fully implemented and tested yet originate from the literature findings and emerged from various studies. Furthermore, they will be subject to further evaluations and studies in the proceeding of the project. It is also important to acknowledge that despite the holistic approach of the presented guideline, it will be key to consider individual strengths, weaknesses, and particularities of workers, managers, workplaces, and companies in the process of implementing and applying this guideline. Individual factors play an important role while dealing with the treatment, support, and prevention of mental health (problems)/mental strain, and when in doubt, professional support should be consulted. Moreover, the findings are originating from German business settings, and therefore the transferability of results might be limited. Obviously, further research is required regarding in-depth guidelines for digitalization steps in logistics processes. Further company insights, additional industries, or country contexts could be analyzed for generalized findings.

6 Conclusion and Outlook

The aim of this paper was to provide insides on the creation of a guideline to prevent mental strain in logistics processes and for logistics workers. Through an analysis of relevant literature and findings from the associated project themes, requirements, and advice on healthy digitalized work emerged. The structure and content of the guideline were successfully created out of this analysis. Managers, researchers, and workers are provided with a guideline that offers hands-on advice on how to prevent mental strain and sustain a healthy digitalized work environment. The findings, however, are not limited to support the field of logistics and should furthermore be able to provide help in a wide field of Industry 4.0 environments. The most crucial aspects that became visible in this paper to sustain a mentally healthy workforce in a digitalized environment are open communication, an optimal workplace design, training of individual strengths and needs as well as a holistic involvement of workers. As one of the most useful advice items on how to prevent mental strain in the workplace, an increase in decision latitude seems to be promising.

As for further research, there seems to be a lack of knowledge in the field of promoting women's health in female-dominated workplaces. Similar to the Canadian study of Seaton et al. (2019) on promoting men's health in male-dominated workplaces, such research should be pursued. After the DIAMANT project, there should be further evaluation of the guideline content based on the experiences gained in the next phases of the project.

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