sustainability

MDPI

*Article*

# Linking the Use of Ergonomics Methods to Workplace Social Sustainability: The Ovako Working Posture Assessment System and Rapid Entire Body Assessment Method

**Brigita Gajšek [1], Anca Draghici [2,*,†], Maria Elena Boatca [2,‡], Alin Gaureanu [2,‡] and Diana Robescu [2,‡]**

[1] Faculty of Logistics, University of Maribor, Mariborska c. 7, 3000 Celje, Slovenia; brigita.gajsek@um.si
[2] Faculty of Management in Production and Transportation, Politehnica University of Timisoara, 14. Remus Str., 300191 Timisoara, Romania; maria.boatca@student.upt.ro (M.E.B.); alin.gaureanu@upt.ro (A.G.); diana.robescu@student.upt.ro (D.R.)
* Correspondence: anca.draghici@upt.ro
† President of the ErgoWork Society in Romania.
‡ Members of the ErgoWork Society in Romania.

**Abstract:** This article concretizes the continuous development of social sustainability in organizations based on ergonomics methods and tools, among others. Numerous scientific studies have already revealed many reasons for justifying balanced efforts towards organizational sustainability, including its economic, social, and environmental dimensions. Because the social dimension is recognized as the weakest and is often neglected, it is placed at the forefront of the present research. The link between social sustainability in the workplace and the ergonomics concept is provided through 17 underlying indicators of the workplace sustainability framework proposed in a previous study. The OWAS and REBA ergonomic risk assessment methods were used in a toolmaking company to study how results can be used directly or indirectly to determine the size or value of indicators used in the sustainability framework. The research finds that direct use of the OWAS and REBA results is not possible, but it is certain that the implementation of proposals in response to identified levels of risk affects up to four out of five factors that constitute the sustainability framework. The use of OWAS and REBA is not suitable to address environmental concerns. This study encourages companies to use ergonomic methods and tools to develop social sustainability in the workplace. It is often necessary to decide between the pen-and-paper approach and an advanced one using artificial intelligence (e.g., supported by the ErgoIA software tool). Not only the method but also the technique chosen affects the degree of sustainability achieved. Finally, relevant aspects of knowledge exploitation in the field of ergonomic education for social sustainability were summarized.

**Keywords:** ergonomics risk; workplace social sustainability; musculoskeletal disorders; ErgoIA

check for updates

**Citation:** Gajšek, B.; Draghici, A.; Boatca, M.E.; Gaureanu, A.; Robescu, D. Linking the Use of Ergonomics Methods to Workplace Social Sustainability: The Ovako Working Posture Assessment System and Rapid Entire Body Assessment Method. *Sustainability* **2022**, *14*, 4301. https://doi.org/10.3390/su14074301

Academic Editor: Hyo Sun Jung

Received: 7 March 2022
Accepted: 1 April 2022
Published: 5 April 2022



## 1. Introduction

According to the International Institute for Sustainable Development (IISD), sustainability is the foundation of today's leading global framework for international cooperation. The most cited definition for sustainable development is from Our Common Future, also known as the Brundtland Report [1]: "Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Aware of the importance of sustainability [2–5], companies are trying to set sustainable development goals and targets in a way that balances three dimensions of sustainable development: economic, social, and environmental [5–8], going beyond the misconception of putting the focus on the economic dimension [9]. Numerous scientific studies have already revealed many reasons to justify the rationale for developing strategies, policies, tactics, and activities that incorporate each dimension of sustainability both separately and in a balanced way [8,10]. Thus, additional proof of the reasonableness of such business practices is no longer necessary. Recent questions include how to constantly improve sustainability and what methods and tools should be used.

Among the economic, social, and environmental dimensions, the social dimension is commonly recognized as the "weakest" pillar of sustainable development [11–13], with calls for research and improvements. United Nations Global Compact [14] states that social sustainability is about identifying and managing positive and negative business impacts on people. Companies, their statement continues, directly or indirectly affect what happens to employees and workers in the value chain. According to Nobel laureate Amartya Sen, social sustainability has five dimensions. These are factors to be considered in determining if a company or a project is socially sustainable: equity, diversity, social cohesion, and quality of life [15]. Researchers at the operational level connect social sustainability and work when researching ways to improve social sustainability in an organizational environment. Work is a direct link to social sustainability's fifth dimension, quality of life, and the following questions:

- Will change improve physical health outcomes for the target group?
- Will it improve mental health outcomes for the target group?
- Will it improve education, training, and skill development opportunities for the target group?

When changing a workplace, a microsystem, where work is performed in a company, is rethought, and another direct connection comes to the fore, namely a connection between Industry 4.0 and work. A recent literature review [15,16] confirms that Industry 4.0 supports the implementation of sustainability concepts because no one reports a reverse relationship. Ref. [16] found some research papers tackling Industry 4.0 and sustainability together, but they were not focused on a specific sustainability concept, dimension, or Industry 4.0 technology. A sustainable Industry 4.0 reference is missing [15]. This shortcoming made impossible the use of a holistic approach to assess Industry 4.0 applications in the social dimension of sustainability. Ref. [17] classifies technologies by their impact on social sustainability. Cloud technology is the most socially sustainable Industry 4.0 technology, followed by big data and analytics. However, these technologies should be used very carefully, as their use can quickly violate the principles of ethics, privacy, and personal autonomy issues related to the sharing of data and applications on the cloud [18]. The toolmaking industry, a highly unpredictable industry due to its variety of products, was chosen for this research. Each product is unique. The implementation of Industry 4.0 technologies is limited, as a high degree of automation cannot be considered due to the wide variety of craft operations in the toolmaking industry. As a result, a limited impact of this technology on the social dimension can be expected because an extreme quantity of factors needs to be considered. This environment makes the testing, validation, and successful implementation of these technologies much more complex than in other industries [19]. Industry 4.0 technologies have been proven to affect the social sustainability of the workplace and the factory. However, due to the specifics of the toolmaking industry, we will not focus on the development of a sustainable Industry 4.0 framework. However, we will monitor the connection between these technologies and social sustainability through a case study.

Although the relationship between ergonomics and social sustainability is recognized, little is known about how the relationship is understood by companies or used in their practices [20]. The driver of interest in moving companies and work as such towards social sustainability is that social sustainability conceptions have extended beyond concerns about the use and preservation of natural and physical resources on the planet to include the social sustainability of companies and the sustainable use of human resources [21]. Human resources are described as the characteristics, behavior, and performance of humans in the workplace, and the interactions between humans themselves and humans and technology. All these are closely related to ergonomics. The International Ergonomics Association (IEA) states: "Ergonomics is concerned with the understanding of interactions among humans and other elements of a system, in order to optimize human well-being and overall system performance" [22]; the definition approach has been recognized and exploited by the already commented upon research in [21]. The concept of sustainability, especially as it relates to the workforce and social dimension, is growing in popularity; however, occupational health problems are still present, and organizations must improve their implemented strategies to cope with these problems [8]. The same authors [8] and many others argue and substantiate that ergonomics and sustainability share many of the same goals and that an ergonomics approach could improve the sustainability of the workforce.

Ergonomics is a discipline with the necessary expertise and methods for analyzing occupational tasks and performance [16]. Ergonomics assessment methods, as an example of methods used by ergonomics professionals, were systematically researched from the perspectives of (1) the frequency of use of observational methods (Rapid Upper Limb Assessment—RULA; Rapid Entire Body Assessment—REBA; The Occupational Repetitive Actions—OCRA; and others), (2) direct measurement methods (grip dynamometer, push/pull force sensors, motion capture, and others), and (3) the format of use of ergonomic assessment methods (software, pencil, mobile) [23]. The study found a more frequent use of many methods, with several new methods emerging compared to the list of methods in the 14-year-old study [24]. Initially, older methods were used such as the pen-and-paper approach, as information technology was still in its infancy. This situation is changing, as evidenced by recent research [23] that has found an increase in the existence and use of computer applications. The frequency of use of the software and pencil formats was revealed to be equivalent for most of the research methods included. A study in 2019 [23] revealed that 24–28% of ergonomists were using some smart device/smartphone apps when surveying.

The link between sustainability and ergonomics needs more attention and exploration. Thanks to the scientific literature, it is now possible to conclude that ergonomics can offer new perspectives on workplace wellbeing which are linked with the social dimension of sustainability [4,8,13,20,21]. However, ergonomic interventions have offered research-based solutions without giving concrete guidelines on integrating the knowledge into the delivery of sustainable development-based solutions [21]. Thus, one of the first steps toward concretization was made by identifying workplace sustainability indicators related to employee ergonomic perceptions [25]. The authors present five dimensions, namely, employee wellbeing, safety concerns, workplace comfort, musculoskeletal health, and environmental concerns, that link workplace social sustainability relevantly to ergonomics. This depiction of structured connectivity supports organizations in achieving corporate sustainability and improving the global sustainability index. This social sustainability framework, one of the first to be organized and implemented comprehensively in the workplace, can also be used to attach several ergonomic tools for measuring and determining the fulfilment of individual criteria under the three dimensions of sustainability.

The guarantors for improving social sustainability through the improvement of ergonomics are defined indicators that are improving due to the change in the ergonomic arrangement. In addition to knowledge on the influencing factors, developed and applied sustainability metrics leading to sustainable industrial development are also needed [26].

Within the context of this article, we aim to demonstrate how the use of a specific novel ergonomics tool, ErgoIA, and selected methods for ergonomic risk assessment (such as the Ovako Working Posture Assessment System—OWAS, and the Rapid Entire Body Assessment—REBA) can and should be linked to social sustainability. Further on, the intention is to define indicators needed to monitor the effect of improvements (such as metrics for measuring the impact of ergonomics on the social dimensions of sustainability). The goal is to improve the behavioral awareness (of managers, researchers, or even students) as it relates to their understanding of how the use of specific ergonomic methods and tools can improve the organizational sustainability index and, in more detail, what linking factors it impacts. For this purpose, the social sustainability framework at work, adopted from the research study presented in [25], will be used as an interface to identify the connectivity between ergonomics and social sustainability. Providing data for the quantitative or qualitative determination of indicator values in the sustainability framework from [25] requires data collection. The collection and use of data require careful handling; the efficiency—effectiveness—relevance performance triangle needs to be associated with an ethical dimension that allows for the risks and uncertainties relating to Industry 4.0 to be considered [27].

This article aims to show an approach to concretizing the link between ergonomic and social sustainability within an organization. It also describes the concrete connections between the selected ergonomic tool (ErgoIA), the methods (OWAS, REBA) and social ergonomics. In addition, the authors share their experiences in training and learning about social responsibility and ergonomics in the faculty environment, where joint theoretical and applicative training has been merged with synchronous and asynchronous practical lessons. This experience can be easily transferred to a company environment involving employees instead of students. Thus, the proposed research approach has been exploited for the teaching and study of ergonomics, and new workplace social sustainability improvement opportunities have arisen from a multicultural working group session.

The structure of this article is as follows: Section 2 presents materials and methods. It begins by reviewing the literature on the links between social sustainability and ergonomics. The descriptions of the motion analysis software ErgoIA, OWAS, and REBA follow. Section 3 describes the results of a case study on the use of ErgoIA in toolmaking and coach-oriented teamwork in a diverse faculty, laboratory, and company environment. Section 4 discusses the results. The article ends with conclusions.

## 2. Materials and Methods

The developed approach for concretizing the link between ergonomics and social sustainability within a production company is based on the use of concrete tools and methods in the below-described toolmaking environment. The research steps that led us to develop the approach are shown in Figure 1.

Before we started looking for scientific articles linking ergonomics to social sustainability, we were open to two possible scenarios. According to the first, we would develop a new model due to a gap in the scientific literature, and according to the second, we would use a model already defined in the scientific literature. In Step 1, we performed the literature review and, based on it, decided to use the existing social sustainability framework for the workplace defined by [25].

In Step 2, an ergonomic tool was selected. Ergonomists use many tools and methods to assess ergonomic parameters. Among them, we chose ErgoIA as an example of an advanced tool to reflect the shift from the pen-and-paper approach to the use of simple data acquisition techniques and artificial intelligence for analysis. With ErgoIA, we performed the analysis according to the OWAS and REBA methods, which proved to be the most appropriate methods according to the specifics of the observed workplace.

In Step 3, we chose a company and workplace from the toolmaking industry to serve as the experimental environment. The choice was purposeful, as this company was not yet thinking about sustainable development and does not systematically improve its ergonomic and health safety conditions. However, they operate in accordance with all applicable safety legislation. They have adopted a code of ethics.

In Step 4, a multicultural working group of people with different backgrounds and work experiences was formed within the 8th International Summer School in August 2021 at the Faculty of Logistics, University of Maribor. Students came from Germany, Slovenia, France, Spain, and Croatia, and trainers from Slovenia and Romania. By mentoring the group, the trainers tried to prove that (1) the tools and methods used are quite easy to use, and (2) a diverse, multicultural group can localize losses and make and evaluate suggestions according to their impact on workplace outputs in the implementation of the work process. In this way, we tested the assumption that even employees in a company with little help from experts will cope with the challenges of improving social sustainability in the workplace. The trainers selected a unique combination of methods and tools used for the global improvement of a working system. Their plan combined indoor activities with practical laboratory lessons (Figure 2). Visits to and observations of the toolmaking company were prepared by trainers and representatives from the toolmaking company. Much emphasis was placed on merging theoretical and applicative training with synchronous and asynchronous practical lessons.

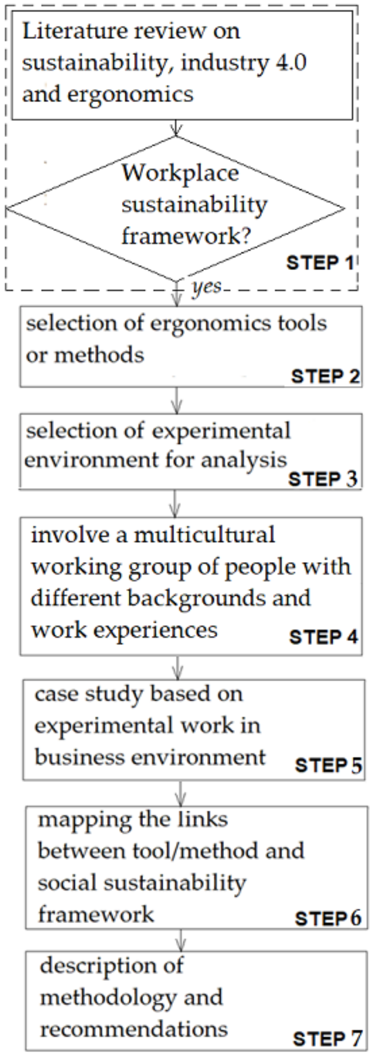


**Figure 1.** Methodological steps.

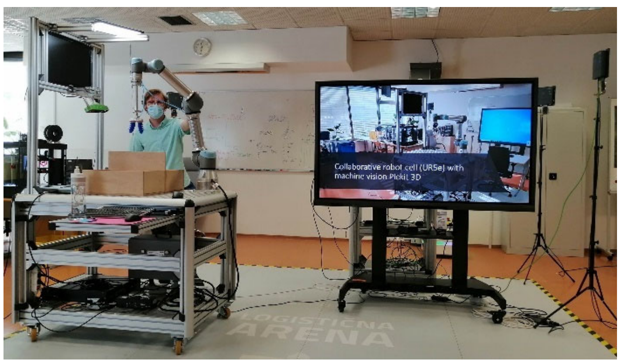

**Figure 2.** Demonstrations and simulations in the laboratory environment.

In Step 5, the above-described group observed and recorded the work in four selected workplaces with a smartphone. They followed the instructions for proper recording [28] provided by the software solution provider. The employees involved in the survey were acquainted with the procedure for obtaining data and the purpose of collecting the data, and signed a consent form to use the collected material. Based on videos, ergonomic risks (particularly postural strains) were evaluated with two renowned methods dedicated to postural analysis and used internationally: OWAS and REBA. Below are the described and analyzed observations from only one of the four observed workplaces; the same pattern appeared in all workplaces.

In Step 6, the results were used to pick those factors from the social sustainability framework in the workplace that were directly influenced by the implementation of the recommendations obtained using OWAS, REBA, and ErgoIA. The research was rounded off with a record of the generalized methodology used, recommendations for further research, and the methodology's application in practice.

In Step 7, the methodology was described and placed in a broader framework considering ethical aspects and the introduction of Industry 4.0 technologies.

### *2.1. The Ovako Working Posture Assessment System*

The Ovako Working Posture Assessment System (OWAS) was initiated in Finland in the OVAKO OY company, a leading European steel bars and profiles producer, to evaluate the smelting furnace workload in the repair process [29,30].

The OWAS method was intended to identify the frequency and time spent in the postures adopted for a given task so as to study and evaluate the situation and thus recommend corrective actions [29]. The OWAS identifies the most habitual back postures adopted by workers (four postures) regarding their arms (three postures), legs (seven postures), and the weight of the load handled (three categories). All this implies up to 252 possible combinations [30]. The process flow of the method is as follows [31]:

1. The starting point is an observation of the workplace and a video/photo recording of workers' movements and postures during the execution of tasks;
2. Each posture is assigned a code. After that, each code is assigned a risk category (from 1 (no harmful effect on the musculoskeletal system) to 4 (very harmful effect));
3. Depending on the risk category, corrective measures are proposed (where applicable);
4. The relative frequency is calculated for the back and feet areas, followed by the attribution of a risk category and the proposal of corrective measures.

The limits of the method are [31]:

a The neck, elbows, and wrists are not assessed;
b Observations and video/photo recordings are time-consuming;
c Repetitive movements are not considered;
d The method is accessible only to specialists trained in the use of OWAS.

### *2.2. Rapid Entire Body Assessment Method*

The Rapid Entire Body Assessment (REBA) method was developed because of the need for a tool with sensitivity regarding the type of unpredictable working postures found in healthcare and other service industries [25]. OWAS is contrary to REBA, which is a general tool that is useful for a broader range of applications but with results that can be low in detail [25]. A team of different specialists collected and individually coded more than 600 postural examples to produce a new tool incorporating static, dynamic, rapidly changing, or unstable postural loading factors, the human load interface (coupling), and the new concept of a gravity-assisted upper limb position [32].

The final REBA Score is defined based on (1) graphical representations of neck, torso, feet, arms, forearms, and wrists postures during work, (2) descriptive step-by-step guidance for determining the partial and final REBA scores, and (3) tables A, B, C for obtaining REBA

Score A and REBA Score B. See the REBA Employee Assessment Worksheet [33] for further clarification of the REBA procedure.

The limitations of REBA are also defined in [34]. REBA:

1. does not consider the duration of the task and the available recovery time;
2. does not evaluate hand–arm vibration risk;
3. only allows the evaluator to assess one employee's worst-case posture at one point in time, thus requiring the use of representative postures;
4. requires individual assessments of the right and left sides of the body, although in most cases the assessor will quickly determine which side of the body has the most significant exposure to the risk of musculoskeletal disorders (MSD).

The output of the REBA tool is the final REBA score, which is a single score that represents the level of MSD risk for the task being evaluated. The minimum REBA score is 1, revealing negligible risk requiring no action. The maximum REBA score is 15. Scores from 11 to 15 indicate very high risk and require the immediate implementation of changes.

### 2.3. Motion Analysis Software ErgoIA

Assessment methods have mainly been developed to require a minimum amount of equipment, namely, only a pen, paper, and a professionally qualified assessor, an ergonomist, serving in the role of the observer. Observations and manual analysis are time-consuming. Recently, more innovative computer solutions have shortened the process and made it accessible and valuable, even for those with lesser knowledge of ergonomics. For example, ErgoIA, created by a team of specialists from the Instituto de Biomecanica de Valencia (IBV), provides innovative technology enabled by artificial intelligence (AI), including computer vision, to evaluate the industrial process workplace ergonomically [35]. The system does not require specialized video capture hardware for further processing, as it allows video to be recorded using mobile devices or regular cameras and does not include any additional (inertial) devices or markers to capture the process. Instead of the assessor, the software counts and analyzes risk movements and generates a document with the analysis from the OWAS, REBA, and repetition standards. The report highlights both the risk levels and the graphical representations of the partial and total scores.

### 2.4. The Selected Company and Workplace in the Toolmaking Industry

A toolmaking company was chosen as the experimental environment. One of the reasons for the choice is that serial production is rarely carried out in toolmaking companies. More often, they perform a handicraft approach. The main goal of these companies is to produce quality tools that are one of a kind. There is little automation of work as the work is diverse in nature. There is much time-consuming manual work, as there is almost no alternative in machining. Ergonomic approaches are rarely used in such companies. Most efforts are invested in technological excellence, and sustainable development is yet to come.

This article focuses on the manufacturing process, or more precisely, the insertion of bolts in the workplace in the production hall, which includes the stamping press, that is, a machine on which different metalworking machine tools are attached that can precisely shape or cut metal according to certain specifications. The press is composed of a bolster plate and a ram. Like the one in our experiment, some large presses have a die cushion integrated into the bolster plate, which can help apply blank holder forces. The forming, drawing, trimming, blanking, and piercing of the metal with a die is completed automatically after the tool is attached to the press. To enable the transformation, the bolts must be inserted into exactly the right holes on the bolster plate, as can be seen in Figure 3. A steel bolster in a cylinder shape weighs 11 kg. Inserting bolts tires employees, and at the same time, the company is finding it increasingly difficult to find employees who would like to do this kind of work.

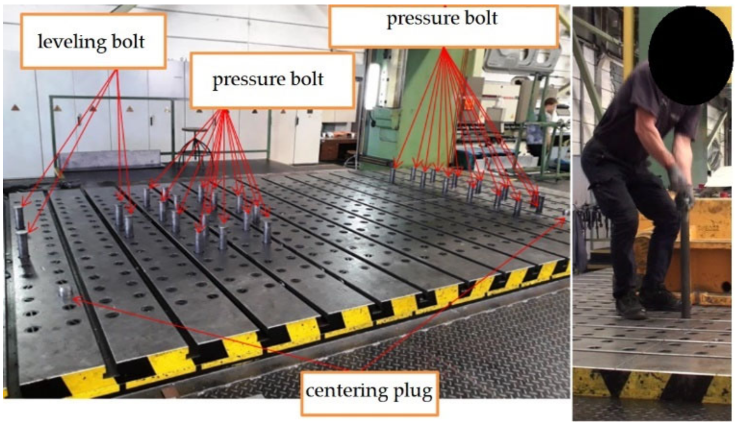


**Figure 3.** Bolster plate with different bolts (**left**) and a worker inserting the bolts (**right**).

## 3. Results

The work activity consists of two tasks: inserting and removing bolts. The operation is part of the preparation for the operation of a metal press. The two tasks are similar, involving roughly the same movements. The main difference between the two tasks is that, for inserting the bolts, the worker holds a paper-based plan with instructions regarding the specific place of each bolt. Therefore, it was considered unnecessary to perform REBA and OWAS for both tasks. The task of inserting bolts was assessed using REBA, and the task of taking the bolts out of the bolster plate was assessed with OWAS.

### *3.1. REBA Analysis*

The video recording was split into 20 frames for the REBA assessment to obtain more details on the worker's movements and postures. The worker needs to step up to the bolster plate, cross the surface, step down from the bolster plate to the podium next to the bolster plate, take a bolt from the rack, and step up again on the bolster plate to insert the bolt. This series of actions is repeated until all bolts are inserted into the holes in the corresponding positions. The variety of movements explains the fluctuation of the risk level in the REBA assessment (Figure 4). The task involves medium and high risks in 50% of analyzed frames, corresponding to situations when the worker lifts and carries the 11 kg bolts and when they step up to/down from the bolster plate, where there is a risk of tripping.

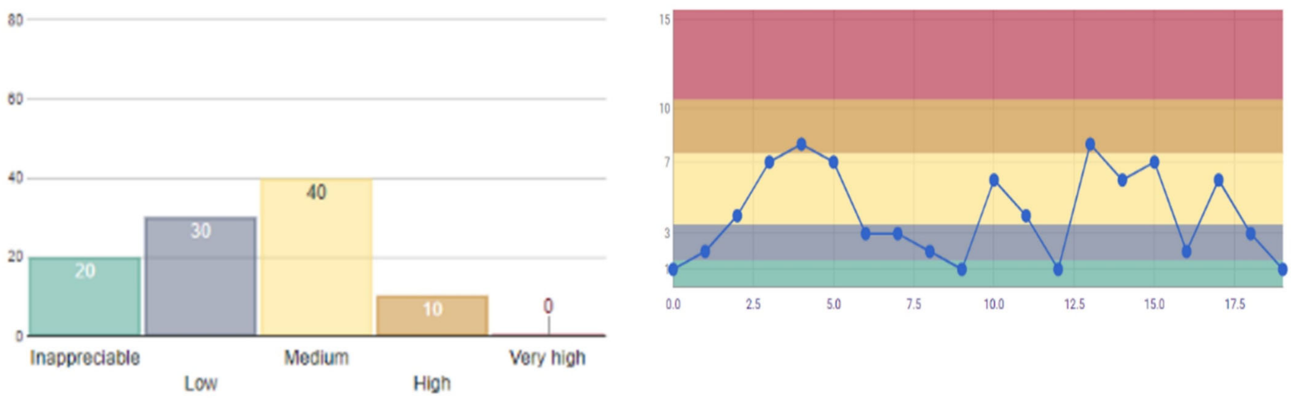


**Figure 4.** Distribution of the general REBA scores—Inserting bolts in holes on the bolster plate.

Figure 5 highlights the wide distribution of risk levels, especially in the Score A category. Score A, Score B, and the final REBA Score result from the standard REBA procedure described in Section 2.2 and [33]. Variations in Score A are explained by the necessity of moving around the bolster plate and podium and performing back-and-forth actions, which impose strain on the back and feet. Additionally, the neck is bent in most of the analyzed frames, as the worker needs to look at the plan or at the working surface to insert the bolt. However, the worker constantly keeps one arm bent at 45 degrees to keep the plan in eyesight and uses the other arm to handle the bolts. The back, arms, and legs are exposed to the highest risks (Figure 6).

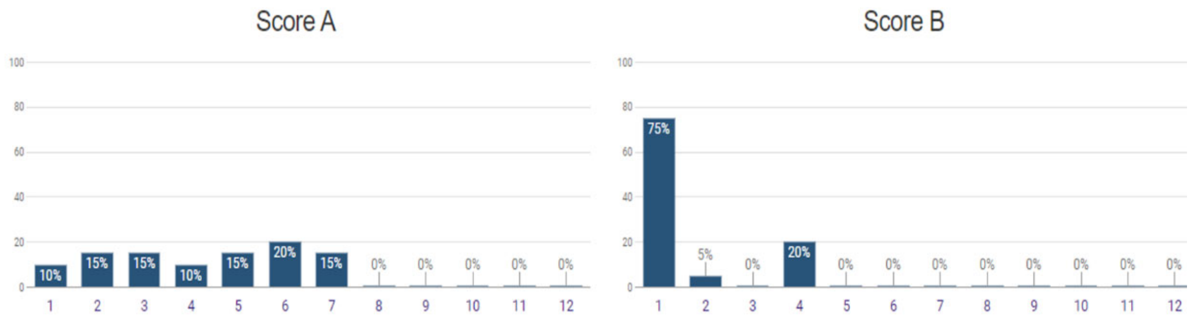


**Figure 5.** Distribution of partial REBA scores—Inserting bolts in holes on the bolster plate.

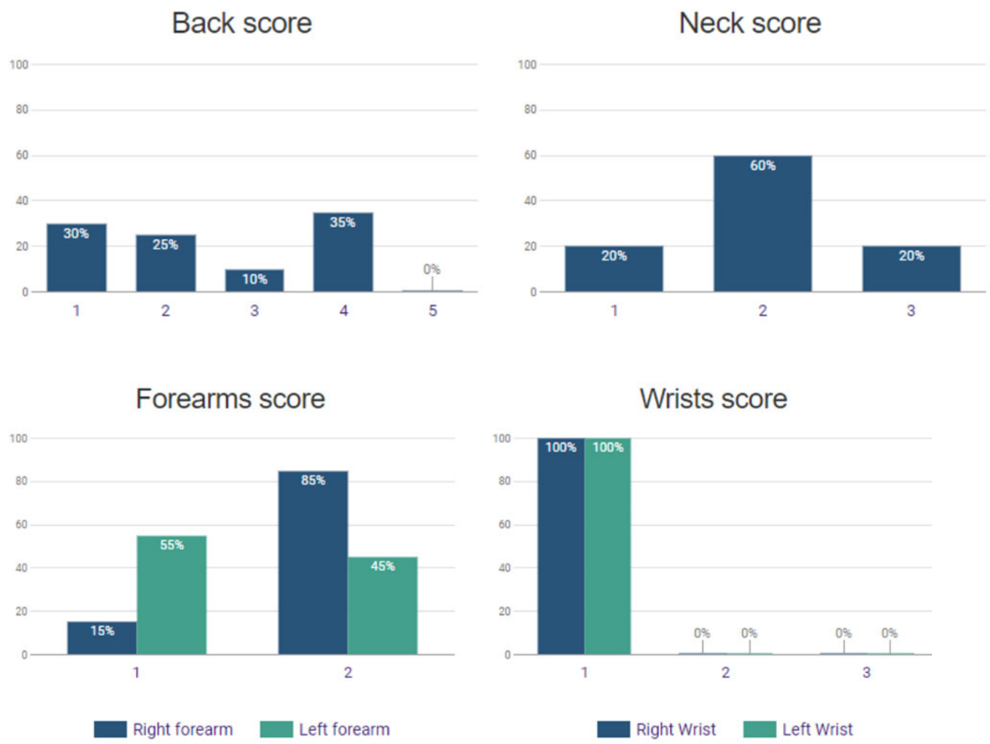


**Figure 6.** Distribution of REBA scores by body region—Inserting bolts in the bolster plate.

### 3.2. OWAS Analysis

The video recording used for the OWAS assessment was split into ten frames and adjusted according to the level of detail required. To remove the bolts from the bolster plate, the worker must pull out the bolts and place them on the rack. However, the risks are similar to those of the task of inserting bolts. The only difference is that the worker does not need to follow a specific plan. Thus, they have the possibility of simplifying the routes. With these considerations in mind, the OWAS assessment highlights numerous frames with medium and high risks, such as the REBA assessment for inserting bolts (Figure 7).

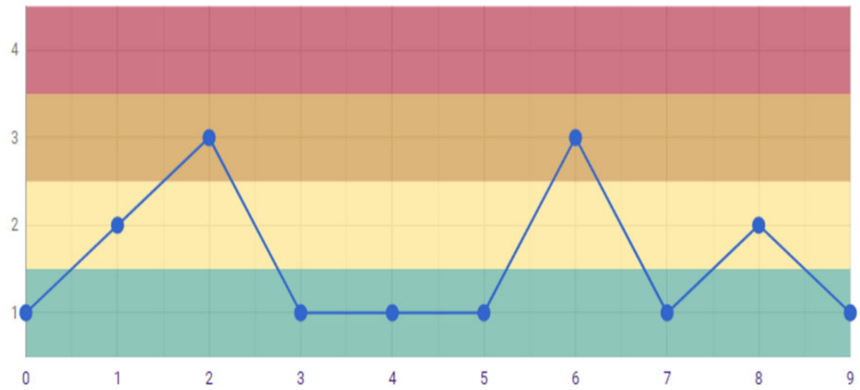


**Figure 7.** Distribution of OWAS scores—Removing bolts out of holes on the bolster plate.

The main postures identified by the OWAS assessment are straight back, bent back, both arms below the shoulder, bent knees, and standing; moreover, 40% of the frames analyzed were scored as medium or high risks (Figure 8). These results reinforce the findings of the REBA assessment and highlight the main ergonomic risks to which the worker is exposed during the removal of bolts.

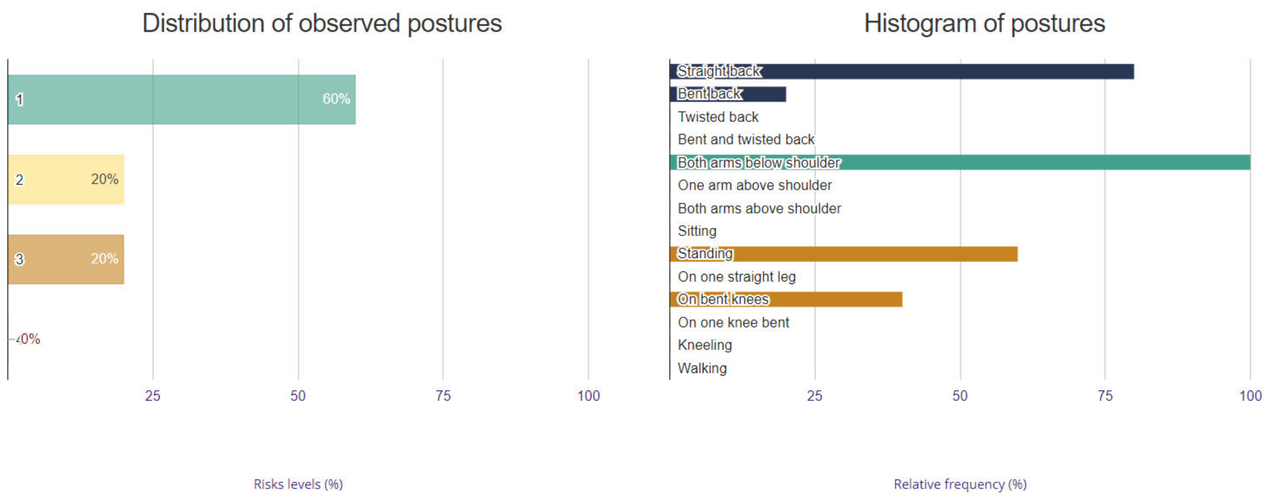


**Figure 8.** Distribution and histogram of postures—Removing bolts out of holes in the bolster plate.

However, Table 1 proposes a few solutions for risk reduction and improving employee wellbeing.

### 3.3. Links between the Use of Ergonomic Methods and Tools and Social Sustainability in the Workplace

The sustainability framework for the workplace proposed by Lin et al. [25] consists of five factors: employee wellbeing, safety concerns, workplace comfort, musculoskeletal health, and environmental concerns (Figure 9). The link between social sustainability in the workplace and the ergonomics concept is provided through 17 underlying indicators.

**Table 1.** An inventory of possible solutions to reduce ergonomic risks.

| # | Identified Problem | Proposed Solution | Type of Solution |
| --- | --- | --- | --- |
| 1. | Manual load handling | Installation of an industrial manipulator will enable the worker to assist the device in inserting and extracting the bolts from the holes; the industrial manipulator would also reduce the time of execution and increase the efficiency of the task | Technical and organizational |
| 2. | Repetitive cycles of knee bending, standing up, taking/placing bolts, walking, and back bending while manipulating bolts | | |
| 3. | The necessity to go back and forth on the bolster plate to reach the rack with bolts | | |
| 4. | The necessity to go back and forth on the bolster plate to reach the rack with bolts | Placing several mobile racks around the bolster plate would reduce the distance and time spent moving to and from the bolster plate surface | Technical and organizational |
| 5. | Risk of tripping | Placing visual signalling (e.g., yellow strips with black text) on elevated surfaces to draw attention to the risk | Risk reduction at the worker level |
| 6. | | Setting up an inclined platform to cover surface-level differences | Risk reduction at the source |
| 7. | The necessity to continuously keep in one hand a paper-based plan while inserting bolts | An electronic device with a screen (i.e., tablet, wearable device) should be placed at a convenient height (adapted to the worker's height) in the vicinity of the press. This device should help the worker visualize the plan while manipulating the bolts with an industrial manipulator | Technical and organizational |
| 8. | Work standing | Introduction of microbreaks to reduce the time of exposure | Technical and organizational |
| 9. | | Training workers to perform stretching and muscle relaxation exercises during breaks and to raise awareness on the implications of standing for long hours | Risk reduction at the worker level |
| 10. | | Reorganization of the work shift for alternation of standing and sitting postures or placement of chairs at the workplace to allow a worker to rest | Risk reduction at the source |

The proposed framework could be transformed into a checklist or a list of performance indicators. Social sustainability maturity in the workplace can only be achieved by carefully considering 17 indicators. At least one ergonomic tool or method should be selected for each indicator to perform an assessment or measurement. The measured value can be expressed as either a value on a Likert scale or a measured numerical value.

Suppose that the company will use the OWAS and REBA ergonomics methods. The result of their use defines the risky postures and the severity of risk of a specific workplace activity. These results cannot be used directly for defining specific indicators quantitatively. Links between the use of the OWAS and REBA ergonomics methods and social sustainability in the workplace can be seen more realistically by implementing solutions according to the recognized risks. The practical use of the OWAS and REBA ergonomics methods in the case of the workplace in the toolmaking company revealed risks and suggested several possible technical solutions, organizational solutions, and solutions for risk reduction at the worker and source level. Table 2 presents intersections between possible solutions based on identified risks using the OWAS and REBA methods and indicators to link social sustainability in the workplace to the ergonomics concepts.

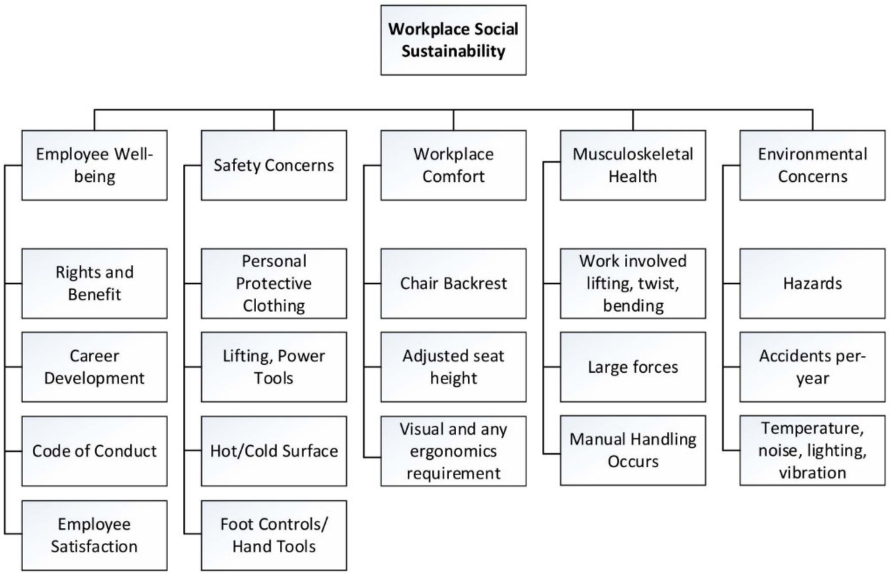


**Figure 9.** The sustainability framework in the workplace proposed by Lin et al. [25].

The first factor is the wellbeing of the employees. In [25], it is presented that this has the most significant importance among the five factors that constitute a framework. Suppose that the rights and benefits of employees, career development opportunities, clarity of the code of conduct, and employee satisfaction while working at the company are appropriately fulfilled; in that case, it is hoped that employee wellbeing can be achieved by supporting social sustainability in the workplace [25]. The introduction of automation and new technology poses the need for training and the acquisition of new competencies that are beneficial for career development. As a risk reduction solution, it is common to instruct employees on the proper performance of tasks, which affects the clarity of the code of conduct. Solutions such as work aids, microbreaks, employee training, and workplace rearrangement directly impact employee satisfaction, giving them a sense of inclusion and affiliation. With the use of OWAS and REBA, it is tough to influence the rights and benefits of employees.

Another important factor is safety concerns. As stated in [25], companies must provide personal protective clothing, lifting and power tools, and foot controls/hand tools. Additionally, to support the realization of safety concerns, exposure to cold and heat at workstations must be considered to provide a sense of security for employees. Solutions that arise from the OWAS and REBA assessments rarely influence safety concerns unless the proposal is technical, such as introducing a new tool.

We could not find organizational solutions and solutions for risk reduction at the worker and source levels derived from the use of OWAS and REBA that would influence workplace comfort, identified as a third factor supporting workplace social sustainability. Only technical solutions such as introducing ergonomic (for example, height-adjustable) equipment and tools directly influence workplace comfort.

The four types of solutions delivered from the risks evaluated by the OWAS and REBA assessment methods tend to reduce the need to lift, twist, and bend, and minimize excessive manual handling activities. The forces needed to perform the task are not measured. However, the masses of objects handled by employees are considered and form the basis for determining risks.

We note no connection between the given solutions for the identified risks from the OWAS and REBA methods and environmental concerns. Rapid Upper Limb Assessment (RULA) and REBA do not include temperature, noise, lighting, vibration, or stress measurements.

**Table 2.** Intersections between the types of solutions and indicators from the sustainability framework in the workplace.

| | | **Technical Solution** | **Organizational Solution** | **Risk Reduction at the Worker Level** | **Risk Reduction at the Source** |
|---|---|---|---|---|---|
| Musculoskeletal health | The work involved lifting, twisting, bending | Lifting devices, height-adjustable function | Job rotation | Training for reduction of risk | Workplace rearrangement |
| | Large forces | Use of balancers, elevators | Additional worker | Training for reduction of risk | Workplace rearrangement |
| | Manual handling occurs | Automatization | Microbreaks | Training for reduction of risk | Workplace rearrangement |
| Workplace comfort | Chair backrest | | | | |
| | Adjusted seat height | Introducing adjustable equipment and tools | | | |
| | Visual and any ergonomics requirement | | | | |
| Safety concerns | Personal protective clothing | | | | |
| | Lifting, power tools | Introduction of lifting/power tools | | | |
| | Hot/cold surface | | | | |
| | Foot controls/hand tools | Introduction of hand tools | | | |
| Employee wellbeing | Rights and benefits | | | | |
| | Career development | Knowledge on use of new technology | | | |
| | Code of conduct | | | Good/expected operating practices | |
| | Employee satisfaction | Work aids | Microbreaks | Training | Workplace rearrangement |
| Environmental concerns | Hazards | | | | |
| | Accidents per year | | | | |
| | Microclimate (temperature, humidity, noise, lightning, vibration, radiation, etc.) | | | | |

### 3.4. *Teaching and Educating Ergonomics for Workplace Social Sustainability*

The launch and implementation of education and training exercises for people with different backgrounds to promote the continuous improvement of social sustainability were tested by working with a multicultural team of students and trainers. The gained experience gave good insight into the feasibility of a similar process for the company, but involving employees instead of students. Above all, it was tested whether ErgoIA is a fast-learning tool and how much knowledge a group of people needs to start working on improving working conditions to improve social sustainability (Figure 10).

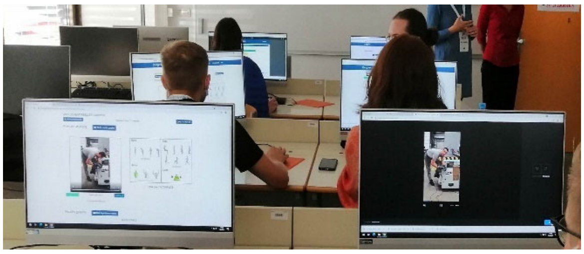

**Figure 10.** REBA and OWAS analysis using the ErgoIA software application.

The trainers come from different countries. They were experts from different fields, namely, ergonomics, safety regulations, business process renovations according to lean production principles, human resources management, logistics, production technology, and sustainability. They were experts in a narrow field of expertise but had an interdisciplinary professional breadth. In addition, the Summer School program valued trainers' expertise and experiences, converging to offering a consistent training program in ergonomics and workplace design with a strong emphasis on the improvement of workplace efficiency and wellbeing.

The program consisted of fluid and logical flows in terms of knowledge transfers (Figure 11), starting with an initial knowledge assessment ("what do we already know?"), continued by learning about the missing theoretical foundations and participating in training sessions on various dimensions of workplace assessment and improvement approaches. The team needed this knowledge to (1) properly obtain the data and materials needed for analysis with ErgoAI, (2) formulate and rank the improvement proposals, and (3) give a well-founded presentation of the final proposal directly to trainers and indirectly to company management. Suggestions for improvements were sought through teamwork (Figure 12).

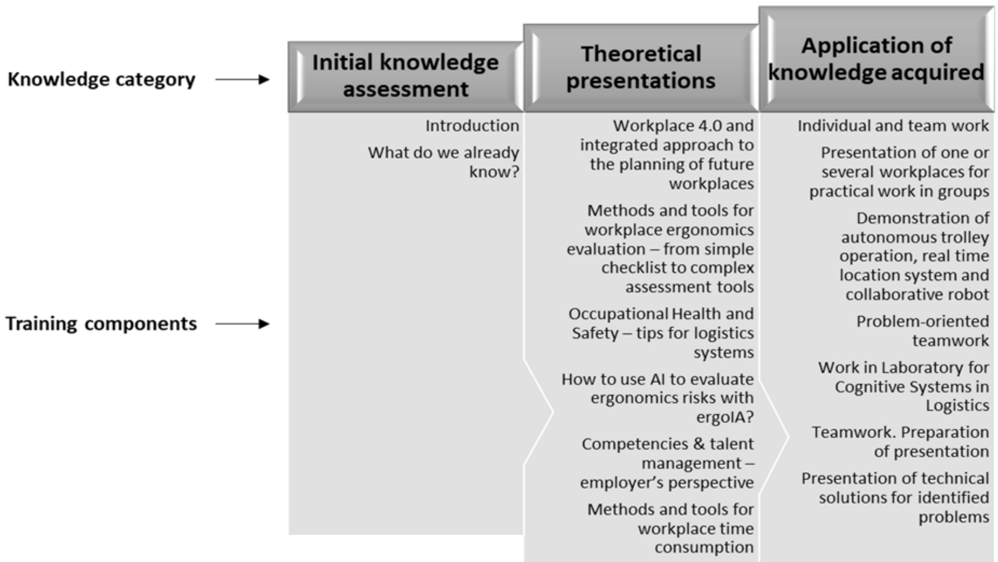


**Figure 11.** Knowledge map of the training elements and related competencies.

**Figure 12.** Teamworking together with trainers.

Teamwork is the best way of utilizing the multidisciplinarity and multiculturalism of those planning the renovation. The training materials and relevant educational resources were available to the trainees and trainers via an internal virtual campus (an application from the Moodle platform) at the University of Maribor for a proper knowledge management approach.

The success of a training program can be expressed in its outcomes, which require a system for evaluating the program. The authors were interested in identifying the strengths of the whole Logistics Summer School curriculum, potential opportunities for improvement, and the possibility of transferring the training concept to the company's employees. On the last day of the Summer School, students and trainers were invited to provide feedback through collaborative SWOT analysis. Key takeaways of the analysis were related to social interaction and collaboration, as all participants expressed positive feedback and the intention to participate in future similar events. However, from a scientific perspective, such an assessment has a very prominent character of subjectivity, hence the need for a well-established tool to evaluate training programs.

One of the most frequently used frameworks for assessing a training program is the four-level Kirkpatrick Model [36]. As per this framework, the outcomes of a training program can be grouped under four categories placed in a hierarchical relationship: reaction, learning, behavior, and results [36]. Figure 13 describes the Kirkpatrick Model in a visually appealing manner. The literature presents a wide variety of studies highlighting the Kirkpatrick Model's key strengths and usefulness in higher education applications: a straightforward language for expressing various outcomes, relevant information regarding improvement areas, and a pragmatic approach to complex training situations [32].

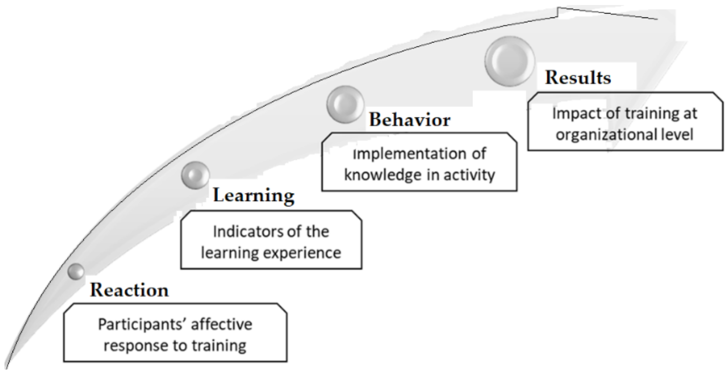


**Figure 13.** A four-level Kirkpatrick Model for training evaluation.

Considering the main advantages of the Kirkpatrick Model, it was used to perform a final evaluation of the training activities and their effectiveness. The results are synthesized in Table 3. Although the Summer School program was mainly oriented towards the learning level, the applicative activities performed in the last part of the Summer School allow for the identification of elements of behavior and results-related levels. However, the results provided in Table 3 are limited to the outcomes assessed during the Summer School. Considering that the students were from various countries and universities, it is not easy to assess to what extent each student can implement the acquired knowledge in their respective university. Therefore, the Kirkpatrick Model presented in this paper is adapted to the particularities of the learning context.

**Table 3.** The Summer School's training program evaluation using the Kirkpatrick Model.

| Training Element | Level | Outcome |
|---|---|---|
| Introduction | Reaction | Expectations and key objectives were clearly defined |
| What do we already know? | Reaction | Students were engaged in clarifying their knowledge |
| Workplace 4.0 and integrated approach to the planning of future workplaces | Learning | Students learned characteristics of the new industrial era, became familiar with maturity models, identified trends and driving forces for development |
| Methods and tools for workplace ergonomics evaluation—from a simple checklist to complex assessment tools | Learning | Students learned what ergonomic assessments involve and how to approach workplace risks |
| Occupational Health and Safety—tips for logistics systems | Learning | The presentation of occupational health and safety implications in logistics helped students understand the legislative framework to follow |
| How to use AI to evaluate ergonomics risks with ErgoIA | Learning | Students were initiated in ergonomics risks assessments using AI-based software |
| Competencies and talent management—employer's perspective | Learning | Students expressed appreciation on how the trainer explained the employer's expectations from a university graduate in terms of skills |
| Methods and tools for workplace time consumption | Learning | Students understood the scientific approach to time analysis for finding a time that does not add value to the product/service |
| Demonstration of autonomous trolley operation, real-time location system, and collaborative robots | Learning | Students and foreign trainers had the opportunity for a real-time experience with state-of-the-art technologies available at laboratories |
| Presentation of one or several workplaces for practical work in groups | Learning | Students learned the particularities of each workplace proposed for analysis and selected one for further activities |
| Work in the Laboratory for Cognitive Systems in Logistics | Learning; Behavior | The session was a learning-by-doing experience, as students were involved in experiments. At the end of the session, they were informed about the results. |
| Individual and teamwork | Behavior | Using ErgoIA, students analyzed data about work in selected workplaces to identify ergonomic risks |
| Problem-oriented teamwork Preparation of presentation | Behavior | Using the knowledge acquired from the training sessions, students formed groups and collaborated for the identification of key problems and the conception of improvement interventions |
| Presentation | Results | Their approach demonstrated creativity, successful knowledge acquisition, and critical thinking. Trainers rewarded the best solution by following the evaluation scheme. |

The Logistics Summer School program distinguishes itself from a typical training program through its multicultural, multinational, and multidisciplinary character, determined by the various nationalities of the trainers and students. Initially a challenge, the multiculturality of the Summer School generated positive outcomes, with both the students and the teachers demonstrating strong communication and teamworking abilities.

We found out that the weak signal problem, described in [37], is lower or can even be neglected if there is a multidisciplinary and multicultural team of experts serving in the role of trainers. The more thoughtfully composed a group of trainers is, the less likely it is that any member of the working group will be ignored, misunderstood, neglected, and the like. We suggest companies conduct workshops with a multidisciplinary team of trainers, and if applicable, with a multicultural team too.

## 4. Discussion

The article overcomes the observed situation in the scientific literature, where much research is still focused on what ergonomic activities can offer. On the other hand, concrete instructions on integrating the accumulated knowledge on ergonomics into sustainable development solutions are lacking [21]. The literature review on the links between social sustainability in the workplace and the concept of ergonomics revealed several attempts and recognized an unambiguous connectivity. However, a few concrete ways to connect would be immediately helpful in practice. The workplace sustainability framework proposed by Lin et al. [25] is the closest attempt to develop a model that is directly usable in practice. It determined the 17 indicators to link social sustainability in the workplace to the ergonomics concept. The authors emphasize the need to find at least one ergonomic tool and method for each indicator, and left the concretization of the methods and tools for further research. The present article precisely addresses this gap in the scientific literature.

In this article, we check which indicators can be influenced by using the OWAS and REBA ergonomic risk assessment methods and thus which can promote the development of social sustainability in the workplace of an organization. Results from OWAS and REBA cannot directly express the size/value of an individual indicator. However, the change in size/value can very likely be triggered by implementing solutions stemming from OWAS and REBA use.

The remaining question is how to determine the size/value of an indicator such as career development. In contrast, it is easy to measure noise and determine whether the measured value is above or below the legally permitted limit. Some indicators are easy to handle, but the rest are not. Evaluation of the indicators “Evaluation of visual and any ergonomic requirements”, “Foot controls/hand tools”, “Rights and benefits”, and “Career development” needs to be clarified in future research. In any case, using ergonomic tools and methods is beneficial, which is certainly reflected in at least one of the indicators, namely “Musculoskeletal health”. The limitation of this research can be seen in the ambiguity regarding the way that expressions of the size/value of some indicators are directly related to the use of ergonomic methods to determine the size of risks.

When we planned experimental work in a specific workplace, we needed to decide between the pen-and-paper approach and the advanced approach using artificial intelligence (ErgoIA) in implementing the OWAS and REBA methods. Not only the method but also the technique chosen affects the degree of sustainability achieved. Paperwork, the monotony of analysis, and the high possibility of errors do not support the sustainable development of the company.

As discussed in the research presented by [27], authors added an ethical dimension to the efficiency—effectiveness—relevance performance triangle, with the justification that the extension is needed for the risks and uncertainties related to Industry 4.0. OWAS and REBA are used to characterize the postures associated with work procedures that are risky for MSD occurrence. The case study showed that different types of interventions and improvements could be based on technical solutions, organizational solutions, solutions for risk reduction at the worker level, and solutions for risk reduction at the source level. The implementation of any change also requires the acceptability of its ethical aspects. As presented in [27], a methodological approach has been developed to consider ethics before or even after implementing changes in a workplace microsystem. Ethics was not integrated into the efficiency, effectiveness, or relevance dimensions, but it was added as an independent dimension. This proposal for improved social sustainability can be evaluated as more or less ethical by considering the ethical dimension.

In another case study on another company, different solutions will be proposed. Some of them will be technological and perhaps chosen between Industry 4.0 technologies. Such solutions have an impact on several key dimensions of company development. Among them, we have previously mentioned the four most frequently discussed. However, digital maturity, Industry 4.0 maturity, and sustainability maturity have also been measured recently [15–17,27]. In the scientific literature, multidimensional treatment across individual dimensions is applied. By observing individual frameworks according to their individual dimensions, the correctness of the approach is quickly realized. Namely, no one justifiably opposes this approach. Bad ergonomics in the form of risky and frequently bad postures can be fixed with technical solutions. The improvement can be seen later in better ergonomics scores (expressed as increasing the working comfort or lowering fatigue) and indirectly in the improved social dimension of sustainability (workers feel respected and treated with care, and the availability of adequate tools for their work diminishes their physical effort). Sometimes the solutions for improving ergonomics indicators accompany the implementation of Industry 4.0 technologies. Such a change can also cause a company to shift to being a mature Industry 4.0 company.

To ensure the improvement of social sustainability in the part that the use of OWAS and REBA can influence, we also need established metrics. An example of the relevant metrics can be found in [26]. Following the introduction of improvements due to periodic ergonomic job evaluations, companies are encouraged to establish and monitor the value of social sustainability indicators. To detect the impact of changes on social sustainability, we suggest monitoring the number of trainings for safe work per employee, the number of safe work audits per workplace, the number of serious diseases per time period, injury rates, the number of occupational diseases, fatality rates, absenteeism, and employee job satisfaction.

The case study also showed the ease of use of the ErgoIA tool as a successor to the pen-and-paper methods of performing ergonomic assessments. With proper mentoring, the test group in the case study quickly mastered the basics and began professional work.

Our experience recommends the introduction of a systematic and continuous process of using OWAS and REBA to assess the ergonomic suitability of workplaces that involves employees in the same way as we did with a group of students. A multidisciplinary approach and, where appropriate, a multicultural one, are important for success. It is recommended to upgrade the implementation of ergonomic workplace assessments into a more advanced system of monitoring and assessing the social sustainability of a company according to the system of indicators.

## 5. Conclusions

This study encourages companies to use ergonomic methods and tools to develop social sustainability in the workplace. Companies should link the assessment results from OWAS and REBA to social sustainability in the workplace through improvement proposals and indicators in the workplace sustainability framework. In doing so, they must not forget to check their ethical acceptability. The use of OWAS and REBA is not suitable for addressing environmental concerns, which is one of the five factors that constitute the workplace sustainability framework.

The limitations of this paper are due to OWAS and REBA being limited to physical ergonomics, while some elements of the proposed frameworks can affect cognitive ergonomics and the factors mentioned above.

The training program developed in the context of the 8th International Summer School has proved the effectiveness of the ergonomic approach and its usefulness for the trainees and trainers. Trainees extended their already achieved knowledge of internal logistics to the social sustainability dimension. Trainers integrated different methods and tools for the ergonomic risk assessment to provide a complete diagnosis of the workplace and thus to elaborate solutions for social sustainability improvement. The Logistics Summer School's learning results prove that the integration of multidimensional approaches in problem solving is a key to the success of social sustainability initiatives.

**Author Contributions:** Conceptualization, B.G. and A.D.; methodology, B.G. and A.D.; software (ErgoIA use and exploitation), M.E.B. and A.G.; validation, B.G., A.G. and D.R.; investigation, B.G., D.R. and M.E.B.; resources, all authors; writing—original draft preparation, all authors; writing—review and editing, B.G. and A.D. All authors have read and agreed on the published version of the manuscript.

**Funding:** This research was partially funded by the Republic of Slovenia and the European Union from the European Regional Development Fund, ROBOTOOL-1 project, grant number OP20.03540. Partially, the publication of the research results was also possible with the support of the Ergonomics and Workplace Management Society in Romania (ErgoWork Society). Also, the results and implications of the research are funded and have been capitalized through our involvement in the project TeachSUS—Teaching and educating sustainability (2018-1-RO01-KA204-049253) which has been funded with support from the European Commission, Erasmus + KA2 action.

**Institutional Review Board Statement:** This study was carried out according to the guidelines of the Declaration of Helsinki and approved by the Research Ethics Committee from the University of Maribor, Slovenia (approval no. 24/03.03.2022). All participants were preliminarily informed about the planned measurements and provided consent prior to the experiments. All procedures and protocols were approved by the company, which provided the case study, and the Research Ethics Committee from the University of Maribor, Slovenia.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Data is available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

**Acknowledgments:** This study was partially related to the authors' demonstration project at the 8th International Logistics Summer School titled "An integrated approach to planning future workplaces, and Competencies in Industry 4.0". The event has been a part of the activities developed by partners in the: "Ergonomics and Human Factors Regional Educational CEEPUS Network" (CIII-HU-1506-01-2021). The authors thank the Faculty of Logistics in Celje, University of Maribor, Slovenia, for supporting this study to be carried out. Special thanks go to the Instituto de Biomecánica de Valencia, Spain, which has provided access and guidance to the ErgoIA software application. Lastly, the authors are exceptionally grateful to anonymous reviewers for their constructive criticism of the manuscript.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. World Commission on Environment and Development. *Our Common Future*; Oxford University Press: Oxford, UK, 1987; Available online: http://www.un-documents.net/our-common-future.pdf (accessed on 27 April 2020).
2. Mann, H.; Kumar, U.; Kumar, V.; Mann, I. Drivers of sustainable supply chain management. *IUP J. Oper. Manag.* **2010**, *9*, 52–63.
3. Laine, M. A New Era of Sustainability: CEO Reflections on Progress to Date, Challenges Ahead and the Impact of the Journey toward a Sustainable Economy. *Soc. Environ. Account. J.* **2011**, *31*, 106–107. [CrossRef]
4. Enhert, I.; Harry, W.; Zink, J.K. *Sustainability and HRM: An Introduction to the Field*; Springer: New York, NY, USA, 2014.
5. Docherty, P.; Kira, M.; Shani, A.B. *Creating Sustainable Work Systems: Developing Social Sustainability*, 2nd ed.; Developing Social Sustainability Routledge: London, UK, 2008.
6. Keijzers, G. The transition to the sustainable enterprise. *J. Clean. Prod.* **2002**, *10*, 349. [CrossRef]
7. Montiel, I. Corporate Social Responsibility and Corporate Sustainability Separate Pasts, Common Futures. *Organ. Environ.* **2008**, *21*, 245–269. [CrossRef]
8. Meyer, F.; Eweje, G.; Tappin, D. Ergonomics as a tool to improve the sustainability of the workforce. *Work* **2017**, *57*, 339–350. [CrossRef]
9. Gladwin, T.N.; Kennelly, J.J.; Krause, T.S. Shifting Paradigms for Sustainable Development: Implications for Management Theory and Research. *Acad. Manag. Rev.* **1995**, *20*, 874–907. [CrossRef]
10. Labuschagne, C.; Brent, A.; Claasen, S. Environmental and social impact considerations for sustainable project life cycle management in the process industry. *Corp. Soc. Responsib. Environ. Manag.* **2005**, *12*, 38–54. [CrossRef]
11. Brent, A.; Labuschagne, C. An appraisal of social aspects in project and technology life cycle management in the process industry. *Manag. Environ. Qual.* **2007**, *18*, 413–426. [CrossRef]
12. Kira, M.; Van Eijnatten, F. Socially sustainable work organizations: A chaordic systems approach. *Syst. Res. Behav. Sci.* **2008**, *25*, 743–756. [CrossRef]
13. Zink, K.J. Social Sustainability and Quality of Working Life. In *Sustainability and Human Resource Management*; Ehnert, I., Wes, H., Zink, K., Eds.; Springer: Berlin, Germany, 2014; pp. 35–55.

14. United Nations Global Compact. Social Sustainability. Available online: https://www.unglobalcompact.org/what-is-gc/our-work/social (accessed on 23 March 2022).
15. Ejsmont, K.; Gladysz, B.; Kluczek, A. Impact of Industry 4.0 on Sustainability—Bibliometric Literature Review. *Sustainability* **2020**, *12*, 5650. [CrossRef]
16. Beltrami, M.; Orzes, G. Industry 4.0 and sustainability: A systematic literature review. In Proceedings of the 10th Annual EDSI Conference, Nottingham, UK, 2–5 June 2019.
17. Bai, C.; Dallasega, P.; Orzes, G.; Sarkis, J. Industry 4.0 technologies assessment: A sustainability perspective. *Int. J. Prod. Econ.* **2020**, *229*, 107776. [CrossRef]
18. Isaias, P. Outlining the issues of cloud computing and sustainability opportunities and risks in European organizations: A SEM study. *J. Electron. Commer. Org.* **2015**, *13*, 1–25. [CrossRef]
19. Byrum, J. The Challenges for Artificial Intelligence in Agriculture. 2017. Available online: https://agfundernews.com/the-challenges-for-artificial-intelligence-inagriculture.html (accessed on 29 August 2021).
20. Brunoro, C.M.; Bolis, I.; Sigahi, T.F.A.C.; Kawasaki, B.C.; Sznelwar, L.I. Defining the meaning of "sustainable work" from activity-centered ergonomics and psychodynamics of work's perspectives. *Appl. Ergon.* **2020**, *89*, 103209. [CrossRef] [PubMed]
21. Haslam, R.; Waterson, P. Ergonomics and Sustainability. *Ergonomics* **2013**, *56*, 343–347. [CrossRef] [PubMed]
22. International Ergonomics Association. What is Ergonomics? Available online: https://iea.cc/what-is-ergonomics/ (accessed on 3 December 2021).
23. Lowe, B.D.; Dempsey, P.G.; Jones, E.M. Ergonomics assessment methods used by ergonomics professionals. *Appl. Ergon.* **2019**, *81*, 102882. [CrossRef] [PubMed]
24. Dempsey, P.G.; McGorry, R.W.; Maynard, W.S. A survey of tools and methods used by certified professional ergonomists. *Appl. Ergon.* **2005**, *36*, 489–503. [CrossRef]
25. Lin, C.J.; Efranto, R.Y.; Santoso, M.A. Identification of Workplace Social Sustainability Indicators Related to Employee Ergonomics Perception in Indonesian Industry. *Sustainability* **2021**, *13*, 11069. [CrossRef]
26. Husgafvel, R.; Pajunen, N.; Virtanen, K.; Paavola, I.L.; Päällysaho, M.; Inkinen, V.; Heiskanen, K.; Dahl, O.; Ekroos, A. Social sustainability performance indicators—Experiences from process industry. *Int. J. Sustain. Eng.* **2015**, *8*, 14–25. [CrossRef]
27. Berrah, L.; Cliville, V.; Trentesaux, D.; Chapel, C. Industrial Performance: An Evolution Incorporating Ethics in the Context of Industry 4.0. *Sustainability* **2021**, *13*, 9209. [CrossRef]
28. Tutorial ErgoIA: OWAS. Available online: https://www.youtube.com/watch?v=Fsfr4JknH-8 (accessed on 30 November 2021).
29. Karhu, O.; Kansi, P.; Kuorinka, I. Correcting working postures in industry: A practical method for analysis. *Appl. Ergon.* **1977**, *8*, 199–201. [CrossRef]
30. Takala, E.P.; Pehkonen, I.; Forsman, M.; Hansson, G.A.; Mathiassen, S.E.; Neumann, W.P.; Sjøgaard, G.; Veiersted, K.B.; Westgaard, R.H.; Winkel, J. Systematic evaluation of observational methods assessing biomechanical exposures at work. *Scand. J. Work. Environ. Health* **2010**, *36*, 3–24. [CrossRef] [PubMed]
31. Gómez-Galán, M.; Pérez-Alonso, J.; Callejón-Ferre, A.J.; López-Martínez, J. Musculoskeletal disorders: OWAS review. *Ind. Health* **2017**, *55*, 314–337. [CrossRef] [PubMed]
32. Hignett, S.; McAtamney, L. Rapid entire body assessment (REBA). *Appl. Ergon.* **2000**, *31*, 201–205. [CrossRef]
33. Middlesworth, M. A Step-by-Step Guide to the REBA Assessment Tool. Available online: https://ergo-plus.com/reba-assessment-tool-guide/ (accessed on 30 November 2021).
34. ErgoIA. ErgoIA Process. Available online: https://ergoia.net/?lang=en (accessed on 30 November 2021).
35. Bates, R. A critical analysis of evaluation practice: The Kirkpatrick model and the principle of beneficence. *Eval. Program Plan.* **2004**, *27*, 341–347. [CrossRef]
36. Cahapay, M.B. Kirkpatrick model: Its limitations as used in higher education evaluation. *Int. J. Assess. Tools Educ.* **2021**, *8*, 135–144. [CrossRef]
37. Vanderhaegen, F. Weak signal-oriented investigation of ethical dissonance applied to unsuccessful mobility experiences linked tohuman-machine interactions. *Sci. Eng. Ethics* **2021**, *27*, 2. [CrossRef]