

Toolkits for hazard identification, risk assessment and prevention of work-related musculoskeletal disorders based on a collaborative platform

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ABSTRACT

Work-related musculoskeletal disorders (WMSDs) is currently not only a health problem in enterprises across six European regions which are Catalonia (ES), Lombardy (IT), South-West Bohemia (CZ) Upper Austria (AU), Estonia (EE), Provincie Noord-Brabantv(NL), but also impacts negatively on productivity and on the competitiveness of enterprises. This project, granted by Innovation 4 Welfare (I4W), will provide a high value to enterprises in the participating regions. However, although EU-legislation has established new and highly innovative technical standards the area of “physical ergonomics, specifically aimed at protecting the “working population” from biomechanical and organizational risks for WMSDs, it is still not easy for users to find a suitable tool or strategy for identifying hazards and assessing risks for purposes of WMSDs prevention effectively. Additionally, there are no criteria or guidelines for teaching users how to select the best method for a specific case. Hence, this project proposes to develop a set of toolkits to help users find the most suitable and effective solution to the problem at hand. Developing toolkits based on a collaborative platform for preventing WMSDs will not only help companies improve and maintain healthy and safe working conditions, but will also promote the creation of new solutions in the field of WMSD and injuries prevention. As a result, it will significantly enhance worker health, life quality and productivity, as well as reduce sick leave absences and economic/social costs connected to work-related muscular disorders and injuries. This paper seeks to illustrate the methodology of developing toolkits for hazard identification, risk assessment and prevention of WMSDs based on a collaborative platform. In order to demonstrate this, the paper presents an analysis of the approaches and the implementation plan for toolkits development. Additionally, the paper closes by suggesting that an essential element for successful prevention of WMSDs is the interaction between the workers and the policy makers, knowledge providers.

Keywords

Hazard identification, risk assessment, musculoskeletal disorder, occupational health, collaborative platform

INTRODUCTION

In industrialized countries, work-related musculoskeletal disorders (WMSDs) and injuries are the most common occupational health problems. WMSDs now account for over 50% of all occupational diseases (with peaks of 85% and 80% in Spain and France, respectively). They reduce company profitability and add to governments' social costs. Figure 1 shows the most common work related musculoskeletal disorders and injuries, which are officers, workers of agriculture, cleaning workers, workers assemble line, workers of fishing industry, and so on[1] [2] [3]. Successful WMSD prevention can therefore greatly contribute to creating more and better quality jobs, as has been demonstrated in a number of successful cases in different work sectors (mainly in manufacturing). Moreover, EU-legislation has established new and highly innovative technical standards [4] [5] [6] [7] in the area of "physical ergonomics, specifically aimed at protecting the "working population" from biomechanical and organizational risks for WMSDs.

However, it is not easy for users to find a suitable tool or strategy for identifying hazards and assessing risks for purposes of WMSDs prevention [8] [9]. Additionally, there are no criteria or guidelines for teaching users how to select the best method for a specific case.

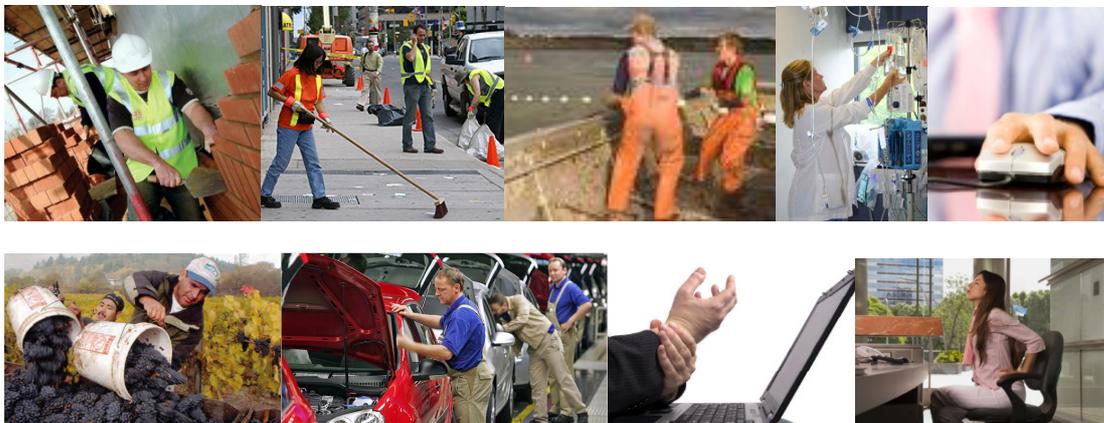


Figure 1 WMSDs and injuries is the most common occupational health problems in many industry countries.

The needs of the following five European regions has been addressed in details. Firstly, in region of Catalonia: according to ECTC survey on working conditions in Catalonia, 49% of Catalonian workers perform repetitive movements commonly associated with musculoskeletal problems. The proportion of women reporting repetitive movements at their jobs was 30.8% vs 27.7% of men. 22.5% of the men and the 19% of the women reported usually or always straining their posture at work, while 50.2% of the women and 41% of the men reported never straining their postures while working. One of the main priorities of the Catalonian Strategy of Occupational Health and Safety 2009-2010 is to promote the quality of risk prevention advice and technical assistance to companies. For this reason, possessing the necessary tools to effectively deal with occupational health problems is a major priority.

Secondly, in the region of Lombardy: WMSDs (mainly tendonitis, lumbar disc hernias and CTS) are the most prevalent occupational diseases. The Regional Authority has promoted a triennial (2008-2010) plan for prevention of accidents and occupational diseases. One specific action is aimed at preventing WMSDs related to repetitive manual work. This specific action is mainly aimed at industrial manufacturing (in factories with more than 20 employees) but could also be extended to other sectors involved in the general triennial plan (i.e. agriculture; building, etc). For WMSD prevention, general guidelines, control procedures and good practices criteria have already been established, but more detailed, and sector-specific tools and good practices are still needed.

Thirdly, in the region of South-West Bohemia: University Of West Bohemia (UWB) is situated in the city of Plzeň, where a lot of both traditional and new companies including SMEs are founded. The companies settled in Plzeň focus on broad spectra of manufacturing fields (engineering, heavy machinery, electronics, textile etc.), where all the branches are relevant to address the WMSDs for the employees. The main aim of the project is to define and implement new methods for WMSDs prevention. The work environment quality enhancement is closely associated with the health of workers. The new methods have a positive influence on health care system which compliances with the regional policy.

Fourthly, in the region of Upper Austria: Between 2000 and 2005, painful positions increased from 26.9% to 34.5% of overall stressful work factors. Heavy loads increased from 21.1% to 22.0% of all stressful work factors; and repetitive movements increased from 40.7% to 47% of overall stressful work factors. The project aims to identify and reduce these risk factors through appropriate tools, knowledge and legal measures.

Finally, in the region of Estonia: For the past 10 years, physical overload disease has been the number one occupational health problem in Estonia, particularly in the textile and garment industry. Office-work involving prolonged computer use also causes musculoskeletal disorders resulting in work-related illnesses, or in their more advanced stages, in occupational diseases. The need for systematic preventive measures, therefore, is obvious. A computer model for implementing EU legislation to prevent musculoskeletal disorders related to nonhazardous load lifting was developed and published by the research group of the Department of Work Environment and Safety of Tallinn University of Technology (TUT) in 2008. The research findings were implemented in textile companies. The need for a more detailed digital model to establish the connection between hazards' influence levels and stages of occupational diseases became evident during EU campaigns on risk assessment and WMSDs.

Hence, this project proposes to develop a set of toolkits to help users find the most suitable and effective solution to the problem at hand. The WMSDs prevention toolkits will contain not only tools/methods, but also guidelines, processes, checklists and templates for the purpose of hazard identification and risk assessment of WMSDs and injuries. After reviewing the existing tools/methods of hazard identification and risk assessment based on a collaborative platform, toolkits with guidelines, checklists and templates will be created. When used with the toolkit guidelines, these templates will ensure that the procedure is complete and that key activities in the process are completed correctly. Additionally, good practices and successful experiences and innovations in WMSDs prevention will be collected and uploaded onto a website in order to share knowledge and promote good practices in WMSDs prevention.

The structure of this paper: firstly, the objectives of this EU subproject have been discussed, and methods which have been applied in developing toolkits for hazard identification, risk assessment and prevention of work related musculoskeletal disorders based on a collaborative platform, finally, the discussion and the conclusion of this project will be made in the end of this paper.

OBJECTIVES

The project has been designed to collate successful experiences, innovations, and examples of good practice in WMSD and injury prevention based on a collaborative platform, and to provide a practical means of adapting and developing effective hazard identification and risk assessment toolkits to reduce the increasing incidence of WMSDs and injuries. It is obvious that sharing and adapting successful experiences, tools/methods and good practices is an effective and practical solution to preventing WMSDs and injuries. Furthermore, the toolkits will be evaluated and improved through feedback and application findings.

This project proposes helping users find the most suitable tool to solve their problem effectively. The toolkits contain not only tools/methods, but also guidelines, processes, checklists and templates for the purpose of hazard identification and risk assessment of WMSDs and injuries. After reviewing the existing tools/methods for hazard identification and risk assessment based on a collaborative platform, toolkits with guidelines, checklists and templates will be created. When used with the toolkit guidelines, these templates will ensure that the procedure is complete and that key activities are completed correctly. Additionally, successful experiences and innovations in prevention of WMSDs and examples of good practice will be collated throughout the duration of the project and uploaded on a website for sharing information and promoting WMSD prevention.

Therefore, the specific objectives of the project are the following:

1. Collate the existing tools/methods, successful experiences, innovations, and good practice of ergonomics interventions;
2. Improve tools/methods, guidelines, checklists and templates for hazard identification and risk assessment by adapting and applying them to new applications;
3. Develop toolkits based on a collaborative platform for hazard identification and risk assessment for WMSD and injury prevention;
4. Disseminate improved toolkits via specified website to promote good practices in WMSD and injury prevention.
5. Produce a report with recommendations for the local/regional authorities on how to foment WMSD prevention.

Developing toolkits based on a collaborative platform for adapting and applying risk identification and assessment methods will not only help companies improve and maintain healthy and safe working conditions, but will also stimulate the creation of new solutions in the field of WMSDs and injuries prevention. As a result, it will significantly enhance quality and productivity, as well as reduce sick leave and social and economic costs related to WMSDs and injuries.

The expected results of this study will include not only improved toolkits for WMSD prevention, but increased application of these toolkits as well. One of the main features and innovations of these toolkits is that they can be improved through feedback and findings based on a collaborative platform, which means: 1) the various toolkits and good practice uploaded by each region can be reviewed and adapted to other regions according to the problem at hand; 2) each region can evaluate and improve the toolkits after adapting and applying them to new applications; and 3) this collaborative platform is interactive and able to be continually updated even after the project has finished. Furthermore, the significance of this project is underlined by the breadth of its possible application to companies, industries, and organizations, and by the opportunity of utilization of the results globally.

METHODS

In this project, the main work and the methodology has been designed to follow the European standard [4] and International standard [5] [6] [7]. The risk assessment model presented here involves three methods. These methods have the same basis, but differ in application complexity. The first method is a quick screening method. Method 2, an easy to handle method, shall be applied if the screening method indicates risks. Some additional risk factors can be taken into account in method 2. Method 3 is an extended assessment method, which assesses risks in a more thorough way and is supplemented by additional risk factors not presented in methods 1 and 2. All three methods have different levels of complexity. The most efficient approach is to begin the risk assessment by applying method 1 (the most simple one) and use methods 2 and/or 3 only if the

assumptions and/or operational situations identified in method 1 are not met (Figure 2).

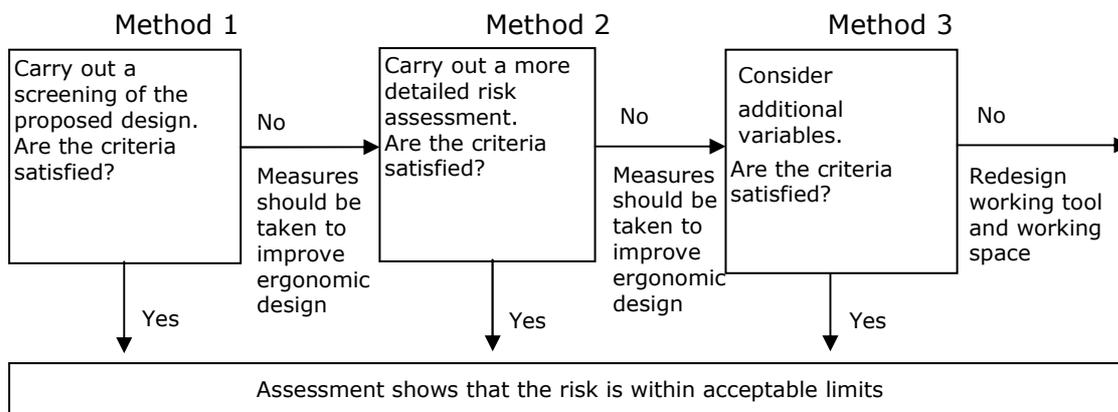


Figure 2 Flowchart identifying the step-wise approach to assessment (EN1005)

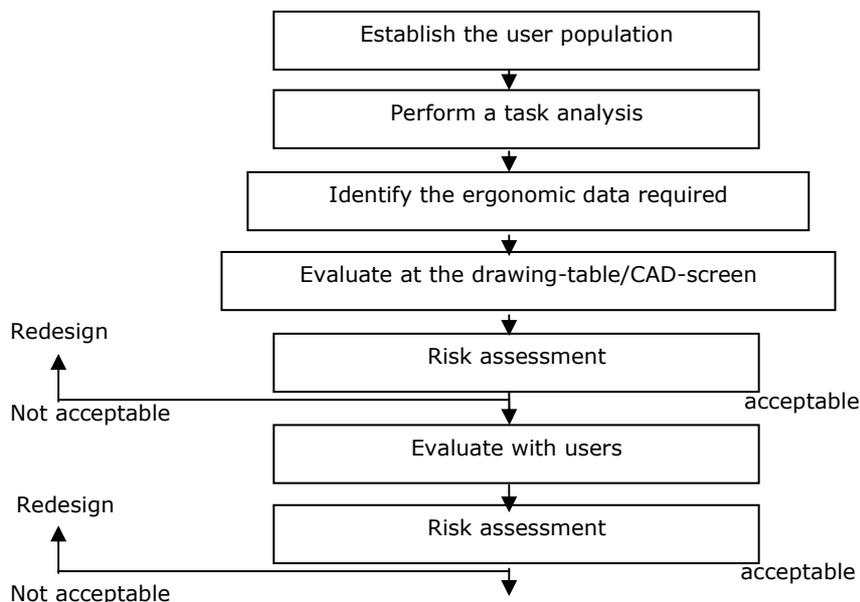


Figure 3 Flowchart for illustrating the risk assessment approach

Figure 3 illustrates the flowchart of the risk assessment approach which will be implemented in this project.

In order to develop toolkits based on a collaborative platform for prevention of WMSDs and injuries, the approach is as following:

First, existing and published tools/methods will be reviewed from a holistic perspective in all regions. Both simple tools and more complex methods requiring significant expertise will be considered.

Second, after reviewing existing tools/methods, all participants will communicate with each other to develop toolkits which include not only the tools/methods, but also guidelines, checklists and templates for helping users select suitable methods to solve their problems effectively. These guidelines, checklists and templates will provide an outline for key hazard identification and risk assessment procedures. A professional website, based on a collaborative platform,

will be created for regions to upload toolkits and successful experiences, innovations and good practices in prevention of WMSDs and injuries.

Third, the toolkits will be adapted and applied to new applications for solving the problems at hand. Successful experiences, innovations, and examples of good practices in WMSD prevention will be collated throughout the duration of the project. Additionally, toolkits will be improved based on feedback and findings of adapted applications. Furthermore, we will disseminate toolkits and good practices via website in order to promote WMSD and injury prevention.

Finally, a report with recommendations on how to prevent WMSDs and injuries will be produced for local and regional authorities. Figure 4 depicts knowledge sharing in WMSD prevention: adapting, applying, and improving toolkits via feedback and findings among all participants based on a collaborative platform. A collaborative platform will provide not only the opportunity to adapt and apply toolkits to new applications, but also the ability to improve toolkits through feedback and post-implementation findings. Thus the collaborative platform will be interactive and continually updatable.

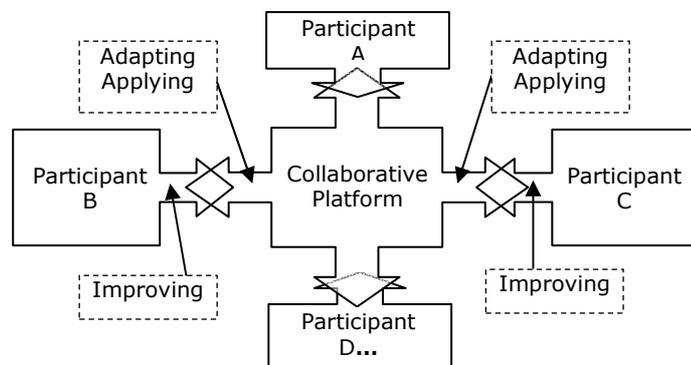


Figure 4 Scheme of knowledge exchanging

This project includes 6 work components. In the following context, the objectives and the research tasks of those 6 work components will be discussed in detail.

Work component 1: Review existing tools/methods and applications to create toolkits with guidelines, checklists and templates

While there are some existing and published tools/methods of hazard identification, risk assessment for prevention of WMSDs and injuries, it is not easy for the users to find a suitable method for their specific problems. Furthermore, there are no criteria or guidelines for selecting the best tool/method. Finally, there are tools which are universally known, but others that are not. As a result, it is urgent to help users find the most suitable tool to effectively solve their specific problem.

The objectives of work component 1 are to (1) review existing tools/methods and current strategies which have been successfully implemented for prevention of WMSDs and injuries in regions through systematic research of different levels and sectors of industry and organization, (2) create toolkits with guidelines (applying protocol), checklist and templates to help select and apply to new applications for new users. In this case, toolkits with different levels of complexity will be created.

An intensive survey will be carried out by the leading participants from a holistic perspective. The following items will be considered when reviewing tools or methods: 1) population, 2) evaluation factors, 3) type of measures, 4) methods of analysis, 5) reports on research or activities, 6) company methods. Both complex methods that clearly require significant expertise and simple tools will be

considered. Tools/methods will be reviewed which are either already being used or that may be amended and made usable by non-experts or experts in ordinary workplaces. Wendy Macdonald and Owen Evans (2006) have comprehensively described these methods/tools, which they have categorized according to the type of WMSDs hazard(s) being assessed [10]. The survey and review of the tools/methods will refer to those categories. The categories used in their report are:

- Postures and loads (emphasis on posture)
- Loads & associated hazards (emphasis on load)
- Repetitiveness and associated hazards
- Wider range of physical hazards (physical work environment, work organization)
 - Both physical and psychosocial hazards (posture, force, repetition, vibration, incentive payments, support, overtime, control)
 - Psychosocial hazards (assessment of risk using questionnaire, relationship with management, being valued, workload issues, psychosocial environmental factors)
 - Adapted for specific jobs or industries (mainly physical factors specific to handling, postures, workplace design, work environment, client characteristics, work organization-work load, isolation, shift, duration, variety; Building industry, Mining Industry; Office work; Data entry/intensive computer use)
 - Measures of stress and fatigue (hazardous personal states, ratings of affective states related to cognitive fatigue, rating or ranking discomfort or pain in specific body locations)

Work component 2: Communicate and share the tools/methods among the participants and develop the toolkits with guidelines, checklists and templates

By the end of work component 1, we will have report reviewing all the existing tools and methods. Furthermore, the criteria for selection of tools will be ready for potential users. Work component 2 will focus on communicating and sharing the tools/methods among the participants and developing the toolkits with guidelines, checklists and templates. As a result, the objectives of the work component 2 are as follows:

- 1) Define the information of the tools/methods, and a final format that is easily understood by the potential users.
- 2) Create an initial website for uploading tools and methods together with the selection criteria and guidelines (applying protocols) for all the leading participants.
- 3) Communicate among all the partners by sharing knowledge and comparing tools and methods used in different regions.

Firstly, the leading participants will define the information tools/methods regarding selection criteria, guidelines, checklists and templates for purposes of toolkit development. Secondly, the leader will receive the criteria of tools and methods. All the information will be published and shared through the website. Finally, an initial website for uploading the toolkits will be created by CEMOC (Italy). Later on, CEMOC will further manage the website.

Work component 3: Collate successful experience, innovations and examples of good practice in prevention of WMSDs

In order that potential users benefit fully from the proposed project, the leading participants will also focus on collating successful experience, innovations and examples of good practice in WMSDs and injuries prevention in each region. Successful experience, innovations and examples of good practices in prevention of WMSDs will be uploaded onto the website for sharing with others.

All the leading participants will begin collating successful experience, innovations, and examples of good practice in prevention of WMSDs from the beginning of the project. The following knowledge should be collated, for example, how the health insurance fee has been reduced by a successful and good practice of prevention of WMSDs in one region. It will take a total 6 months to collate the relevant knowledge and information on good practices and innovations. Meanwhile adapting and applying the developed toolkits to new applications will be carried out.

Work component 4: Adapt and apply the toolkits to new applications

Due to communication among all the partners, and the website in which all the toolkits are uploaded, a collaborative platform has been created that will clearly help users find the most suitable tools to solve their problems effectively.

Consequently, the objectives of component 4 are to adapt and apply the preferred WMSD prevention toolkits in new applications. Toolkits will need to be evaluated in terms of guidelines, checklist and templates through a process of adaptation and application.

Before adapting and applying the toolkits, it will be necessary to correctly and effectively identify and assess hazards and risks in the sectors of the regions. The work will follow European Standard [4] and International Standard [5] [6] [7]. The templates of the toolkits will also refer to the previous one (Wendy Macdonald and Owen Evans, 2006) to ensure comprehensive identification and assessment of all relevant hazards.

Inside the template, the different types of WMSD hazards to be identified and assessed will be categorized into 6 items: (1) Physical task demands that may cause hazardous activities and/or hazardous personal states; (2) Perceptual, cognitive and psychomotor task demands that may cause hazardous activities and/or hazardous personal states; (3) Overall job demands; (4) Physical environment; (5) Psychosocial environment; and (6) Employee characteristics. In addition, the following items will also be considered during the adapting and implementing of tools/methods: 1) population, 2) evaluation factors, 3) type of measures, 4) methods of analysis.

Some selected toolkits will be evaluated through a procedure of adapting and applying according to the practical problems at hand. Finally, the feedback and findings of this adaptation and application procedure will be incorporated into written reports for purposes of toolkit improvement.

Work component 5: Improve toolkits and update website for disseminating toolkits and good practice

After the adapting and applying activities, evaluation feedback and findings will be useful for improving toolkits. And the improved toolkits and methods can be used by further users. Therefore, work component 5 will focus on improving and refining the toolkits based on the feedback and findings in terms of assessment methods, measure methods, analysis methods, guidelines, checklists and templates. Updated information on toolkits will then be posted on the website for general dissemination.

Firstly, the leading participants will collect feedback and findings from the adapting and applying activities. Secondly, the leading participants will need analyze the feedback and findings, and modify the toolkits. Thirdly, they will send the information on the improved toolkits to the leader of the project for updating on the website.

Work component 6: Produce report with recommendations for the local/regional authorities

The objectives of work component 6 consist mainly in producing a report with recommendations on the prevention of WMSDs and injuries for local/regional authorities. The local/regional authorities include employers, contract managers, training organisations, manufacturers and health care policy makers. This work will

ensure that the advice provided for reducing work-related musculoskeletal disorders and injuries is practical for companies.

Firstly, the recommendations will be produced based on project feedback and findings relating to work organisational change (i.e. work scheduling and work practises and job extension, communication/social support networks) and organisational strategies (i.e. reporting systems for WMSDs and injuries, procedures for risk assessment, training programme design, equipment selection, maintenance procedures, workplace design, etc.). Secondly, the leading participants will communicate with the local/regional authorities based on the recommendations regarding prevention of WMSDs and injuries. Thirdly, the recommendations will be written both in 5 regional languages.

DISCUSSION

About one third of the workers in the European Union are engaged in painful or tiring postures for more than half of their working day, and close to 50 % of workers are exposed to short repetitive tasks, which are most often accompanied by painful and tiring movements (EN1005-4). Pain and fatigue may lead to musculoskeletal disorder, reduced productivity, and deteriorated posture and movement control. The latter can increase the risk of errors and may result in reduced quality and hazardous situations.

The proposed subproject has been designed to develop toolkits for identification and assessment of risk factors to prevent work-related musculoskeletal disorders (WMSDs) and injuries based on a collaborative platform. The toolkits and the collected successful experience and innovations in prevention of work-related musculoskeletal disorders and injuries will help target users including employers, contract managers, training organisations, manufacturers and health care policy makers find the most suitable tools and strategies to effectively identify hazards, and assess and control risk.

Therefore, the expected results from this subproject will include not only improved toolkits for prevention WMSDs but also the good practice and successful experience and innovations from all countries and regions. The toolkits will help companies improve and maintain healthy and safe working conditions; while successful experience and good practices will further promote the creation of new solutions in the field of WMSDs and injuries prevention.

On the other hand, we suggest that an essential element for successful prevention of WMSDs is the interaction between the workers and the policy makers, knowledge providers.

Additionally, there are gender issues associated with the project, they have been adequately taken into account. In some cases, men and women have different limitations in terms of physical and psychology factors from a statistic point of view. These differences, as set out in European standards, should be considered to identify risk factors and to define interventions to improve working conditions. Therefore, with this subproject, the gender issues have been adequately taken into account to guarantee the health care for both men and women.

Finally, there are ethical issues associated with the subproject, but they have also been adequately taken into account. In designing the workplace, disabled people or people injured by work-related musculoskeletal disorders must be taken into consideration. The proposed project will help give those people the opportunity to exercise their right to work. Therefore, the ethical issues have been adequately taken into account.

CONCLUSION

As we can make a conclusion, WMSDs is currently not only a health problem in enterprises in all regions, but also impacts negatively on productivity and on the competitiveness of enterprises. The development of this subproject will provide a high value to enterprises in the participating regions.

One of the main features and innovations of those toolkits is that they may be improved by feedback and findings based on a collaborative platform, which means: 1) the various toolkits and applications uploaded by each region can be reviewed and adapted by other regions according to the problem at hand, 2) each region can evaluate and improve the toolkits after applying tools to prevent the WMSDs and injuries and 3) this collaborative platform is interactive and open to continuous updating. In addition, as there are 5 leading participants from 5 different countries and regions involved in this subproject, the final impact of the proposed subproject on the target users will be significant. The significance of the proposed subproject is underlined by the breadth of possible applications for companies and organizations, and by the broad opportunities for using the results, in general.

Hence, the proposed subproject will significantly enhance health care, life quality and productivity, effectively reduce sick leave and economic/social costs connected to work related muscular disorders and injuries. Therefore, the proposed subproject will contribute to achieving the strategic objectives of I4W in the following two areas: It increases competitiveness through innovation and transition to a knowledge-based economy; It stimulates the creation of new solutions in the field of health related issues.

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REFERENCES

1. Woods, V. and Buckle, P., Musculoskeletal ill health amongst cleaners and recommendations for work organizational change, *International Journal of Industrial Ergonomics* 36 (2006) 61-72.
2. Keyserling, W.M., Armstrong, T.J. and Punnett, L., Ergonomic Job Analysis: A structured approach for identifying risk factors associated with overexertion injuries and disorders, *Applied Occupational Environment. HYG.* 6: 353-363 May, 1991.
3. Nordander, C., *Work-related musculoskeletal disorders – exposure assessment and gender aspects*, Lund, 2004. ISBN 91-628-6151-4
4. EN 1005 Safety of machinery – Human physical performance: Part 1): Terms and definitions; Part 2): Manual handling of machinery and component parts of machinery; Part 3): Recommended force limits for machinery operation; Part 4): Evaluation of working postures and movements in relation to machinery; Part 5): Risk assessment for repetitive handling at high frequency.
5. ISO 11226, Ergonomics — Evaluation of static working postures
6. ISO 11228, Ergonomics — Manual handling — Part 1: Lifting and carrying; Part 2: Pushing and pulling; Part 3: Handling of low loads at high frequency
7. ISO 14738, Safety of machinery — Anthropometric requirements for the design of workstations at machinery
8. Risk assessment essentials, European Agency for Safety and Health at Work, <http://hwi.osha.europa.eu>
9. Guidelines on the collection, evaluation, and dissemination of good practice information on the internet, Version 07, Gilbao, July 2000. European Agency for Safety and Health at Work

10. Wendy Macdonald and Owen Evans, Report of research on the prevention of work-related musculoskeletal disorders stage 1 – Literature Review, 2006. ISBN: 0 642 32643 6