

A simple tool for preliminary hazard identification and quick assessment in craftwork and small/medium enterprises (SME).

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Abstract. During the last Congress of the International Ergonomics Association (IEA), Beijing, August 2009, an international group was founded aimed at developing a “toolkit for MSD prevention” within IEA and in collaboration with World Health Organization (WHO). Possible users of toolkits are: members of health and safety committees, health and safety representatives, line supervisors; labor inspectors; health workers implementing basic occupational health services; occupational health and safety specialists.

According to ISO standard 11228 series and the new *Draft CD ISO 12259-2009: Application document guides for the potential user*, a computer software (in Excel®) was create dealing with hazard “mapping” in handicraft

The proposed methodology, using specific key enters and quick assessment criteria, allows a simple ergonomics hazard identification and risk estimation. Thus it makes possible to decide for which professional hazards a more exhaustive risk assessment will be necessary and which professional consultant should be involved (occupational physician, safety engineer, industrial hygienist, etc.).

Key words: handicraft, ergonomics hazards, biomechanical overload, toolkit

1. Foreword

One of the most recent activity lines being implemented by World Health Organization (WHO) as to work-related disease prevention, is setting up toolkits for quick and overall identification of possible risk inductors, easily usable by a number of possible users among whom, prevention operators, occupational physicians, workers and trade unions, employers and surveillance operators.

On the other hand this target is related to what published in ISO 11228, ISO 11228- ,2 ,3 standards and related Application Document Draft CD ISO 12259 (in preparation) [4, 5, 6,7, 8, 9] with special reference to quick assessment criteria (green/critical conditions) (DRAFT CD ISO 12259-2009).

The present contribution provides a first computer-based operative tool. It has been originated by suggestion and aims of the above mentioned International working group and fully

sets into the WG spirit and goals satisfying the preliminary proposal requested by WHO and IEA to develop a toolkit for WMSDs prevention.

2. Introduction and aim: problems on risk assessment in handicraft and small enterprise

The small handicraft is the backbone of our productive, occupational and economic system, recalling approximately 95% of Italian enterprises that have less than 10 workers. In occupational terms, at the end of 2007, the workers employed in this sector were assumed to be over 1,500,000 (equal to 14% of total employment at national level, excluding agriculture and the public sector), with 11% occupational increase between 2001 and 2007.

Risk assessment is a complex operation needing:

- identification of risk sources present in the working cycle;

- identification of consequent potential safety and health exposure hazards;
- estimation of exposure hazards associated with identified prevention situations.

Several checklists [5], [10, 11, 12, 13, 14, 15, 16], were published being aimed at supporting employers and technical consultants in risk assessment in small/medium companies. Such tools however proved to be rather difficult requiring quite developed technical skills.

The work here presented is aimed at providing a simple methodology enabling the employers to draw the first mapping of diseases/hazards (that is identification of risk sources present in the working cycle existing specially in the handicraft). Such tool is not meant to replace the risk assessment process but to support it in order to pinpoint hazardous situations present in the company, needing a more in-depth assessment process. Besides, such tool will allow to identify more easily (by employer and/or Prevention and Safety supervisor) the situations needing - in the assessment stage – the presence of an occupation physician or other specializations .

Moreover this tool can be used by:

- occupational physicians during periodical inspections and protocol preparation for health surveillance;
- safety workers' representatives for periodical monitoring of hazardous situations at workplace;
- surveillance bodies during inspection at workplaces as a tool for a quick identification of possible hazardous situations needing special preventive actions.

The methodology objectives can be summarized in the following three points:

- **global** : to get a global interpretation of worker's discomfort either originated from work place or work environment.
- **simple**: to set up an easily usable information collection model, by using a computer-based closed-reply questions (Excel® based).
- **efficient in defining priority scales** : the results (automatically achieved from software and easily readable through summarizing histograms) will help identify problems as well as provide a priority scale for subsequent assessment fulfillments.

3. Pre-mapping methods : the pre-mapping model (simple tool)

The first (basic level) involves a quick and overall identification of possible risk inducers through specific *key enters*. This level must ensure all users (with any degree of competence) an overall and at the same time simple interpretation of the workplace. This basic level is subdivided into a variety of “frames” for each type of risk: load manual handling, upper limb repetitive movements, postures, noise, microclimate, chemical agents, work organization, etc..

The subsequent level (first level) involves quick identification through quick assessment techniques of full risk acceptability conditions (marked, with the traditional light system, by green code) or very high risk conditions (critical code). For green code (green light) the risk assessment process may be interrupted at this level since the working risk turns out to be acceptable.

For critical codes situations, the risk is certainly present asking for a quick improvement action: it is however necessary to proceed with a more in-depth risk assessment using reference tools and standards currently available..

If after *quick assessment* the workplace is neither at negligible risk (green light) nor in clearly critical conditions (that is the situation in which a potential yellow or red code could be present) the risk has to be analytically assessed through risk analysis and estimation models as proposed by ISO standards.

The methodology described, materializes into an easily usable information collection tool already computer based:

en_PREMAPPING_ERGOCHECK_18-7-11.xls that can be freely by www.epmresearch.org.

The tool provides a preliminary general overview of all the main risks likely to arise in handicraft and gives indications if the related diseases are expected to be originated from the work place or the working environment.

In the following a more detailed description of the tool is made.

3.1 Identification data (ID) and basic intervention level through key-enters

a) ID data of enterprise

After a general description of the enterprise, pre-mapping forms are to be filled. The forms are addressed to one worker or one group of workers (homogeneous group) with the same job characterized by the same working task/s in the

shift. The job actually describes all the tasks developed in one shift or anyhow over an even longer period of time.

b) *Key-enters for identification of assessment priorities for biomechanical overload risks (Figure 1)*

Considering now the variety of “biomechanical” risks, they are identified in terms of presence/absence through key-enters, the same as proposed by ISO 11228 standards 1-2-and 3 and ISO 11226 and in the CD ISO 12259 DRAFT in preparation.

Key-enters are quite simple questions that are to be replied by a YES/NO reply.

Such extremely simple questions enable the people in charge with analysis of work-related risks to know quickly when further analysis is needed or not.

As to the biomechanical overload from spine and lower limb awkward postures, instead of key-enters provided by standards (actually not present), simple discomfort interpretation criteria were used based on checklists and/or questionnaires and/or ergonomics handbooks [5,] [10] to [16].

While for repetitive movements and load manual handling specific quick-assessment forms have to be filled in (2nd assessment stage), for awkward postures of spine and lower limbs) and subsequent physical and organizational risk indicators, more structured even if simple questions are proposed, toward the assessment and prevention action priority scales..

In particular, based on enclosed images, the main postures assumed at work have to be identified by a cross and their percentage duration (the sum of the durations shall in any case be equal to 100%).

Once the forms have been filled the tool makes the evaluation. The results will appear in a qualitative form expressed by different light colours: green (absence of discomfort), yellow (slight discomfort), red (significant discomfort worth further appropriate investigation), purple (discomfort indicating the presence of a critical situation worth of urgent investigation). Intentionally these preliminary indicators omit the scores but use only a chromatic priority scales easily expressing on one side the absence of the problem and on the other the need to tackle with the matter.

Beyond the key enters at item b) the following key-enters are considered in the software tool

developed (detailed in the tool but not described here for space problems): :

c) Key-enters for identification of interior lighting problems

d) Key-enters for identifying outside work-related problems – UV radiations

e) Key-enters for identifying noise-related problems.

f) Key-enters for identifying problems associated with microclimate

g) Key-enters for identifying problems associated with use of equipment/tools

h) Key-enters for identifying problems associated with vibration exposure

i) Key-enters for identifying problems associated with use of machinery or parts of machinery. l) Key-enters for identifying problems from polluting agents (chemical hazard, biological hazard) and other particular risk factors

m) Key-enters for identifying organizational problems

n) Key-enters for identifying problems generically associated with potential stress inductors

3.2 The first action level by quick assessment

Once possible (absent/present) risk inductors have been identified through key-enters, we can proceed ,only for those that have been pinpointed, through a *quick assessment simplified procedure*.

This procedure, while meeting basic assumptions and criteria, does not use calculation schemes or formulas but deals with three different targets:

- recording of critical conditions: the critical codes (purple light)
- recording of acceptability conditions: the green codes (green light)
- if recorded conditions are neither critical nor acceptable, it is necessary to proceed with traditional risk assessment methodologies as provided by reference standards.

After applying the procedure, if all the acceptability condition criteria are fulfilled and no critical codes are present, the related condition is defined as acceptable and no further assessment will be necessary.

When the results are not in acceptable areas and also for critical conditions (when necessary) is appropriate to proceed with a more detailed assessment, according to schemes or equations

already provided by (ISO and CEN) standards and above all with improving actions.

For biomechanical risks the criteria proposed in the Technical Report being prepared at ISO (DIS ISO/TR 12259- Application document for ISO 11228 series) proved to be quite useful and hence were used. The quick assessment procedure will be analysed in more detail in the following.

Also for the chemical hazard, a detailed sheet is proposed still representing a more detailed descriptive part. After overcoming the key enter level, it allows a more detailed investigation of hazardous situations in order to define the more or less urgent need to complete the assessment procedure

For the other physical risks listed in the key-enters sections, other more experienced group could work out in the future for developing specific quick-assessment techniques, if possible.

a) Quick assessment of repetitive tasks (Table 1 and 2)

Once a repetitive work has been determined by key enter, as defined in it, the special sheet has to be filled in. Please note that when speaking of repetitive work, the term does not mean presence of risk. A work can be defined as repetitive when organized in cycle (regardless of length) or when the task is characterized by the same working movements going on always the same for over 50% of time.

The first part of the sheet requires study of some organizational data. The second part proposes scenarios allowing to state that repetitive work developed by the homogeneous group is not at risk if all the replies have been negative (green code). The third part proposes other pre-set scenarios allowing to state that the repetitive work developed by the homogeneous group implies high risk critical conditions (critical code, purple light) even if only one reply is positive..

In short, the quick assessment sheet filling for study of repetitive works, leads to the three following conclusions:

- the repetitive work is at acceptable risk (green code);
- the repetitive work could be at risk It is necessary to proceed with risk assessment using traditional tools;
- the repetitive work is surely at risk with critical code. A risk assessment has to be made urgently

through traditional assessment tools when necessary for a specific re-design.

As already referred for key-enters, also for quick assessment results, interpretation scores are not made visible but only the risk and action priority chromatic scales mentioned above.

b) Quick-assessment of load manual handling (Table 3, 4)

Once load manual handling has been established through key enter, as required, the quick assessment sheet is filled in.

The first part of the sheet requires data about characteristics of environment and of lifted objects that could hinder their correct handling.

The second part proposes other pre-set scenario allowing to state that lifting involves high risk critical conditions (critical code, purple light) even if only one reply should be positive. These are the scenarios for which RNLE method of NIOSH [2],[3] proposes multiplier 0 for calculation of recommended weight (practically when present, the recommended weight is equal to 0 kg and hence manual handling is to be avoided). Furthermore a critical condition is assumed to be present when one worker only has to manually lift weights exceeding the max lifting limits suggested by ISO 11228-1 and CEN1005-2 technical standards by gender and age.

The third part proposes scenarios allowing to state that lifting by homogeneous group is not at risk (green code) if all replies are negative about their presence.

In short, quick assessment sheet filling in for study of load manual handling work, leads to the following three conclusions like for repetitive movements:

- manual handling is at acceptable risk;
- manual handling could be at risk: it is necessary to proceed with a risk assessment through traditional assessment tools;
- manual handling is surely at risk. It is necessary to proceed urgently with risk assessment by traditional assessment tools and with improvements of the scenario that proved positive.

c) Quick assessment of load manual carrying (Table 3-4).

As preliminary quick assessment the cumulated mass (standard ISO 11228-1) that is the total weight of all loads carried in one shift, is assumed as a reference parameter. The transferred cumulative

mass is compared with the cumulative mass tolerable for 8 hours: if the transported mass should be higher than the tolerated mass, a critical situation would occur (critical code, purple light). The tolerated cumulative mass varies versus transport distance, from 10000 kg for 8 hours to 6000 kg for distances exceeding 10 m.

d) *Quick assessment of load pulling and/or pushing*

The proposed scheme requires the description of used trucks (see the model detailed in the software)

3.3 Description and preliminary outline of chemical polluting agents

A useful descriptive scheme of possible polluting agents is suggested.

Once the product presence and classification (qualitative data) have been acknowledged specific indications are given in the software tool developed.

4. Example of application

Once all the required data are reported in pre-mapping sheet, above described, the final results appear indicating priorities. The reported example deals with workers cutting serpentine, a precious stone from Valtellina used for valuable coating (e.g. roofs).

The homogenous group carrying out the same working tasks in the shift consists of 5 workers. It does not work in quarry but in laboratory (humble and obsolete) outside which, stone blocks (25 to 50 kg) extracted from quarry are carried. By manual trans-pallet, such blocks are carried into the laboratory where, by manual tools (special clubs and chisels), precious stone slabs are obtained. The big pieces of stone from quarry are first divided into smaller pieces, with weight between 10 and 20-25 kg, that are generally manually handled. The stone has to be cut along the direction of stone natural crystallization to obtain slabs: and this asks for skill and experience. The stone contains silica: in the quarry the serpentine might be close to asbestos veins.

In this example, the homogeneous group of workers carries out several tasks, from piece transport by trans-pallet to manual transport to stone cutting. The pre-mapping sheet has to be filled to describe the whole activity developed by a homogeneous group.

The work is repetitive and involves high risk conditions (critical code) given the presence of force peaks. The manually lifted loads can exceed 25 kg (critical code). There are problems associated with manual trans-pallet pulling and pushing given the ground conditions outside the laboratory. Noise and microclimate are, on average, problematic. Equipment is obsolete and may produce injury. Silica (and perhaps asbestos) may be present even if for stone cutting manual hammers rather than grindstones are used, no air fans being present.

Figure 2 shows the final synthetic results, automatically obtained from software, represented by histograms for all the inductors in parallel, for comparison purposes.

Histogram heights are obtained from percentages

$$Pi / PMi * 100$$

where

PI i= intrinsic score value of inductors derived from the sum of scores ascribed to the single parameters describing it and appearing on recording.

PMi= max prefixed score of inductor

5. Conclusions

A methodology for the mapping of the working discomfort and hazard is proposed.

The method is implemented into a computer-based software allowing an easy data collection and evaluation.. It provides a general overview of all the main risk descriptors that can arise in handicraft and gives a concrete response to the ergonomic basic criteria suggesting a global interpretation of discomfort elements in line with the strategies of new European standards.

Two analytical levels are foreseen in the tool, following ISO standards and criteria: the key enter (yes/no) and quick assessment (critical codes and green codes) level, this last fully developed only for, biomechanical overload and partially for chemical hazards.

The tool developed, with special reference to Musculo-skeletal-disorder, is in line with WHO and IEA aim to set up toolkits to be used also by un-experienced workers for risk identification and management.

References

- [1] CEN. EN 1005-2. Safety of machinery - Human physical performance - Part 2:Manual handling of machinery and component parts of machinery. 2003

- [2] COLOMBINI DANIELA., OCCHIPINTI E., et al: *Movimentazione manuale dei carichi: manuale operativo per l'applicazione del Dec.Leg81/08*. Dossier Ambiente: 2010;89, primo trimestre.
- [3] COLOMBINI DANIELA., G. DI LEONE, E. OCCHIPINTI, MONTOMOLI LORETTA., RUSCHIONI ANGELA, GIAMBARTOLOMEI MAURIZIA, ARDISSONE S., FANTI M., PRESSIANI SOFIA., PLACCI M., CERBAI M., PREITE S.: Ipotesi di tecniche semplificate per la prima mappatura dei rischi professionali nel settore artigiano. Prima parte: rischi legati all'ergonomia".G Ital Med Lav Erg 2009; 31:3; 292-296
- [4] DRAFT CD ISO 12259-2009: *Application document guides for the potential users of the ISO 11228-1, 2, 3:- Standards and ISO 11226 on Working Postures*
- [5] ENKVIST INGA-LILL, HAGBERG M., WIGAEUS-HJELM EWA, MENCKEL EWA, EKENVALL LENA AND PROSA: STUDY GROUP: Interview protocols and ergonomics checklist for analysing overexertion back accidents among nursing personnel Applied Ergonomics1995, 26-3, 213-220.
- [6] ISO 11226. Ergonomics — Evaluation of static working postures. 2000
- [7] ISO 11228-1. Ergonomics - Manual handling - Lifting and carrying – 2003
- [8] ISO 11228-2. Ergonomics - Manual handling - Pushing and pulling– 2007
- [9] ISO 11228-3. Ergonomics - Manual handling - Handling of low loads at high frequency– 2007
- [10] MALCHAIRE J., *Strategia SOBANE e guida per l'individuazione dei rischi, versione 1,2*. 2008. Direction general de humanisation de Travail, Unione Europea.
- [11] MINISTÈRE DE L'ÉCONOMIE, DE L'INDUSTRIE ET DE L'EMPLOI *Identification du questionnaire Republique Francaise SUMER 2009*.
- [12] NIOSH Checklist per l'analisi generale dei rischi ergonomici; www.societadiergonomia.it/download/down/90.doc
- [13] OSHA Ergonomics checklist: progetto per gli standard ergonomici OSHA. checklist per la valutazione del luogo di lavoro; www.societadiergonomia.it/download/down/89.doc
- [14] OHSW PROCEDURE: OHSW16. Workplace inspection-General Environment. Workplace; www.unisa.edu.au/ohsw/forms/docs/OHSW16.doc
- [15] OHSW PROCEDURE: OHSW41. Plant Hazard Identification & Risk Assessment. Workplace. www.unisa.edu.au/ohsw/forms/docs/OHSW41
- [16] REXROTH BOSCH GROUP: *La check-list dell'ergonomia per i sistemi di lavoro manuali - Una guida alla creazione di posti di lavoro ergonomici*; www.fsm.it/gimle/31/3/10

Figure 1

Key-enters for identification of assessment priorities for biomechanical overload risks

B1	BIOMECHANICAL OVERLOAD OF UPPER LIMBS IN REPETITIVE TASKS PRESENCE OF REPETITIVE TASK. The filter-check is to be applied when the task is organized in cycles, regardless of their length or when the task is characterized by the if yes go to the sheet REPETITIVE-MOV	YES	X
		NO	
B2	BIOMECHANICAL OVERLOAD FROM MANUAL HANDLING - LIFTING PRESENCE OF OBJECTS WEIGHTING MORE THAN (OR EQUAL TO) 3 KG TO BE MANUALLY LIFTED (if the weight is less, no need to continue the investigation) if yes go to the sheet MANUAL HANDLING	YES	X
		NO	
B3	BIOMECHANICAL OVERLOAD FROM MANUAL HANDLING - CARRYING PRESENCE OF OBJECTS EXCEEDING 3 KG TO BE MANUALLY CARRIED (if the loads are less, no need to continue the investigation). if yes go to the sheet MANUAL HANDLING	YES	X
		NO	
B4	BIOMECHANICAL OVERLOAD FROM MANUAL PUSHING AND PULLING ARE MANUAL PUSH AND PULL CARRIED OUT?	YES	X
		NO	

REPETITIVE TASK[S]- QUICK ASSESSMENT: ACCEPTABLE CONDITION [GREEN AREA]			
a	Are either upper limbs working for 50% or more of the total time duration of repetitive task[s] [upper limb saturation ≥ 50%]?	NO	YES
b	Are one or both arms [elbows] held at shoulder level for more than 10% of the total duration of the repetitive task[s]?	NO	YES
c	Is a moderate force exerted by the operator for more than 25% of the total duration of repetitive task[s]?	NO	YES
d	Are there force peaks exerted by one of both of the upper limbs also for very short periods?	NO	YES
e	Lack of breaks that last at least 8 min. or more almost every 2 hours?	NO	YES
f	Are the repetitive task[s] performed for more than 8 hours a day?	NO	YES
If all the questions are answered "NO" then the task[s] is in the GREEN AREA [acceptable] If one or more of the questions is answered "YES" then evaluate the repetitive task[s] by ISO 11228-3			

Table 1

Repetitive task[s]- quick assessment: acceptable condition

Table 2.
Repetitive task[s]- quick assessment: critical condition

REPETITIVE TASK[S]- QUICK ASSESSMENT: CRITICAL CONDITION [*] [**]. If only one of the following conditions is present, risk has to be considered as CRITICAL and it is necessary to proceed with URGENT task re-design then by ISO 11228-3			
a	Are technical actions of a single limb so fast that cannot be counted by simple direct observation?	NO	YES
b	One or both arms are operating with elbow at shoulder height for half or more than the total repetitive working time	NO	YES
c	A "pinch" grip [or all the kinds of grasps using the fingers tips] is used for more than 80% of the repetitive working time.	NO	YES
d	There are peaks of force [perceived effort = 5 or more in CR-10 Borg scale] for 10% or more of the total repetitive working time?	NO	YES
e	There is no more than one break [lunch break included] in a shift of 6-8 hours?	NO	YES
f	Total repetitive working time is exceeding 8 hours within a shift?	NO	YES

Table 3.
Manual lifting and carrying task[s]- quick assessment: acceptable condition

CONSIDER THE REPORTED RECOMMENDED CUMULATIVE MASS [total kg carried in the considered period for the given distance]: is effectively carried a cumulative mass LESS than recommended values considering distances [more/less than 10 meters] and periods [1 minute; 1 hour; 8 hours] ?				
	For no more than 10 m	For more than 10 m		
8 hrs	10000	6000	NO	YES
1 h	1500	750	NO	YES
1 min	30	15	NO	YES
	Awkward postures during the carrying are not present		NO	YES

Table 4
.Manual lifting and carrying task[s]- quick assessment: critical condition

Tab 4- LIFTING AND CARRYING-QUICK ASSESSMENT : CRITICAL CONDITION [CRITICAL CODES]. If only one of the following conditions is present, risk has to be considered as HIGH and it is necessary to proceed with task re-design		
CRITICAL CONDITION: presence of lay-out and frequency conditions exceeding the maximum suggested		
VERTICAL LOCATION	Hands at the beginning/end of the manual lifting, higher than 175 cm or lower than 0 cm.	YES
VERTICAL DISPLACEMENT	The vertical distance between the origin and the destination of the lifted object is more than 175 cm	YES
HORIZONTAL DISTANCE	The horizontal distance between the lifted object and the body center of gravity [medium point between the ankles] is more than 63 cm	YES
ASYMMETRY	Asymmetry angle [upper body rotation] more than 135° degrees	YES
FREQUENCY	More than 15 lifts per min in SHORT DURATION [manual handling lasting no more than 60 min. consecutively in the shift, followed by at least 60 minutes of break-light task]	YES
	More than 12 lifts per min in MEDIUM DURATION [manual handling lasting no more than 120 min consecutively in the shift, followed by at least 30 minutes of break-light task]	YES
	More than 8 lift/min in LONG DURATION [manual handling lasting more than 120 min consecutively in the shift]	YES
CRITICAL CONDITION: presence of loads exceeding following limits		
Males [18-45 years]	25 KG	YES
Females [18-45 years]	20 KG	YES
Males [<18 o >45 years]	20 KG	YES
Females [<18 o >45 years]	15 KG	YES
CRITICAL CONDITION FOR CARRYING: presence of cumulative carried mass greater than those indicated		
carrying distance 20 m or more in 8 h	6000 KG	YES
carrying distance less than 20 m in 8h	10000 KG	YES

Figure 2

Final synthetical results being viewed through histograms for all the inductors set in parallel for comparison purposes.

