

## Implementing ‘Awakened Need of Change’ for Applying Ergonomics to Work System with Macroergonomics Approach in an Industrially Developing Country and its Meta-Reflection

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### Abstract

This study aimed to create macroergonomics awareness and wakefulness at the organizational level at a manufacturing company with emphasis on understanding the importance improving “Working Conditions Systems” (Health, Safety, and Ergonomics) and understanding the necessity of applying ergonomics to work system. It sought to develop a vision and ideas as well as drawing up checkpoints for the organization of work when the research could be with company and the participation of participants, not only on people or techniques and tools. The survey approach was used. Data was collected from several steps with different sample participants: 1) Three questionnaires were conducted on managers viewpoint (29 people), on health, safety and environment staff’s viewpoint (5 people) and operating worker’s viewpoint (85 people), 2) Using of the “Future Workshop” for middle managers (15 participants), 3) Using of ILO ergonomics checklist in one of units of the company (29 participants), 4) Evaluating the workshop among middle managers (15 participants), 5) Interview with some participants in “Future Workshop” (10 participants) and, 6) interview with some participants involved in applying the ergonomics checklist (4 participants), 7) Review of the organizational documents was used. In the data collection, the participants were made to study the organizational knowledge with different PDSA cycles of learning and the desire of understanding for changing the improving working condition system when an external and internal facilitator team was formed. Based on the analysis of participants feedbacks on the implementation of different work evaluation approaches and their reflection from learning, key findings were made through intentional learning on PDSA Cycles of learning, based on a systemic pre-macroergonomics intervention work process on how the participants could be ‘empowerment through reflection’ with the different getting learning understanding when there were the different concepts of “learning” and reply on the appreciative inquiries as a meta- reflection.

**Keywords:** Macroergonomics; Work system; PDSA cycles of learning; Awakened Need of Change; Macroergonomic intervention; Industrially Developing Countries (IDCs)

### Introduction

#### The significant role of macroergonomics and important sub-systems

In the 90s’ decade, the interest in ergonomics issues in a wide sense grew in enterprise level, as a result of an increasing awareness of the importance of those matters for corporate core values such as productivity, quality and an inevitable change process [1]. Hendrick is attributed macroergonomics with the formalization of Organizational Design and Management (ODAM) in ergonomics [2]. For many years now (since the early 1980s), O DAM factors become an accepted field of research for ergonomics. For this reason that (‘Historical Development of Macroergonomics’ by Hendrick): Macroergonomics is a top-down sociotechnical system approach to the design of work systems and the application of the overall work-system design of the human–job, human–machine, and human–software interfaces [2,3]. It is the formalization of attention to O DAM factors in ergonomics [4]. Macroergonomics is based on, the sociotechnical systems framework, which dates back to English coal mine studies performed, by Trist and Bamforth of the London Tavistock Institute [5].

Hendrick claimed, “Good ergonomics is good economics” and defended this point with 25 case studies showing the business value of macroergonomic interventions work [6].

Experience from Industrialized Countries (ICs) and also Industrially Developing Countries (IDCs) shows that consideration of macroergonomics play a significant role in creating the appropriate

working environment in which participants are motivated to participate and better utilize company resources for increasing system productivity, reliability and availability [7-14].

Hendrick noted that macroergonomics intervention begins with an assessment of the relevant sociotechnical variables and their implications for the design of the structure of the work system and processes [15,16]. Once key characteristics of the overall work system have been determined, microergonomics prescriptions, such as how to optimally allocate functions and tasks to humans and machines, can be accomplished [16]. A sociotechnical system is a bounded, purposeful enterprise comprised of people whose purpose is to transform inputs into outputs [17]. The system is open in that it exists in and is influenced by an environment [4]. Mumford states that sociotechnical system design has two important components (i.e., to humanise work and support democracy at work) [18]. According to Trist et al., some of the primary principles of socio-technical system are as follows [19]:

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- Work organizations consist of two independent yet interdependent systems: the technical system (equipment, machinery, chemical processes, etc.) and the social system (individual workers and groups of workers).
- The work system is the basic unit, comprising a set of activities that make up a functioning whole, rather than single jobs and tasks.
- The work group, rather than the individual jobholder, is central.
- Regulation of the system is performed by the group itself, instead of by supervisors (completely counter to Taylor's scientific management notions).
- An individual worker is complementary to the machine, rather than an extension of it.
- In sociotechnical theory, the system is broken into three sub-systems: technological, personnel, and job design [16]. The technological sub-system contains the tools, technology, work rules, and processes that convert system inputs into outputs [16].

As illustrated in the Work System Sub-Systems are several important sub-systems, including the personnel sub-system, technological sub-system, organizational job and task design, and the internal and external environments [7,20]. The three major principles behind sociotechnical system theory [21] are: 1) Joint causation (i.e., a characteristic of sociotechnical systems is that they are open systems); 2) Joint optimization (i.e., if the personnel or technological sub-system were to be optimized, the result would be a sub-optimized system); and 3) Joint design (i.e., joint optimization is achieved through joint design. According to Kleiner and Drury, these can be factors of a successful macroergonomic practice [22]. The requirements of each sub-system are considered along with the influence of the environment in designing the system) [16]. There are at least three major characteristics of the personnel sub-system these are sensitive to the design of an organization's work system structure [15]: 1) The degree of professionalism; 2) Demographic characteristics; and 3) Psychosocial aspects of the workforce.

For this reason that the three major sociotechnical system elements include the: (1) Technological subsystem; (2) Personnel subsystem; and (3) Relevant external environment that permeate the organization [23]. Empirical models have been developed that study each of the sociotechnical system elements in relation to the effects upon the three organizational design dimensions of complexity (degree of differentiation and integration that exist within a work system's structure, formalization (degree of differentiation and integration that exist within a work system's structure.), and centralization (degree to which jobs within the work system are standardized. Centralization—where formal decision-making occurs within the work system [3,24].

Macroergonomics is concerned with the optimization of work system design through the consideration of relevant social, technical, and environmental variables and their inter-actions [22]. An important outcome of macroergonomics intervention is a culture change, where organizational culture is primarily defined as organization's core values, but which also includes traditions and unwritten rules [2,25]. Kleiner in Europe, there has been a strong tradition to investigate ergonomics problems within a holistic, systems context. "Macroergonomics" builds upon this tradition by providing specific methods and tools that yield large-scale results [20].

## **IDCs, the Ergonomists' work and their common outcome of the past activities in IDCs**

It is noted about IDCs and the ergonomists' work that "Talking about ergonomics in relation to IDCs means that we have to define what is an IDC, not by economic criteria (e.g., GNP (Gross National Product)) but by population, prevailing forms of work and work ethic [26]. The case in point is studies of ergonomists who had conducted interventions in IDCs such as H. Shahnava, K. Kogi, H.W. Hendrick, PA Scott, A. Wisner and others was reviewed by Yeow and Sen [27]. On the other hand, the development and the need for ergonomics in IDCs is emphasized by Scott when Ergonomics can play a key role on assisting developing areas to break out of their negative poverty-driven spiral. Indeed, ergonomics can be a major factor in narrowing the gap between the "rich" and the "poor" nations of the world [11]. For this reason that, the working conditions in IDCs have been described by Shahnava, Scott, and Scott and Shahnava as 'suboptimal', 'physically demanding' and a 'complex array of problems' [28-30]. The lack of awareness about the potential benefits of ergonomics is the primary cause for underutilization of ergonomics principals. There is, however, no doubt that application of micro and macroergonomics is essential for improving working conditions, system efficiency and promotion of the quality of working life in IDCs [31].

One special and common outcome of the past activities in IDCs, regarding various types of ergonomics interventions and ergonomics awareness building in IDCs was the low involvement of ergonomists, the low degree of industry involvement, the short term impact of training and the low effect of training on the organization as a whole, mostly due to the fact that individuals have received the training and not the groups or organizations [7,8].

This is emphasized that for an ergonomics 'know-how' transfer management to IDCs' industries, need to a more challenging 'comprehensive plan and planning' with different ergonomics intervention techniques and its strategies with an intentional learning [7,8]. For this reason, there was a problem in focusing on problems because, deficit-phrased questions lead to deficit based conversation [32,33]. For example, according to Helali observed that it is mentioned as a definition of a problem in industries of IDCs like Iran, there are technical focus managers at work, a lack of interfaces between individual, group, and organizational levels at work, unsuitable work systems and unsuitable informal relationships within the organizations, and poor livelihood [33].

The main attention of ergonomists work in IDCs was on 'ergonomics awareness' (i.e., understanding without knowing) and working conditions when IDCs' industries need to further of here for ergonomics awakening (understanding with knowing) to purpose applying the ergonomics and human factors to work system in the organizations [8,33,34].

## **Necessity of the applying macroergonomics in IDCs' industries**

Shahnava asserts that the advent of new technology, especially through technology transfer, imposes numerous health and safety problems on IDCs workplaces, which hampers the company's competitiveness [13]. However, the emphases for improvement limited to few progressive companies focuses on microergonomics which caused by traditional thinking, cultural issues and lack of knowledge and skill needed to deal with macroergonomics approach. Helali observed that it is insufficient for firms rely on only training, awareness creation,

and ergonomics intervention when addressing safety, health, and ergonomics issues [7]. For this reason, Helali noted that both practical learning and reflection learning should be provided at all levels of the organization. Such provision could lead to the emergence of better organizational interventions, underlined by macroergonomics attitude in firms, when implementing systemic ergonomics intervention work at the workplaces [7,34].

The ergonomics intervention work in IDCs will be best achieved through macroergonomics input, which triggers with even no-cost/low-cost microergonomics improvements [7,34]. Productivity improvement is also a key issue in IDCs [7,12,13]. The success of no-cost/low-cost improvements actually depends on the careful selection of feasible solutions. Consequently, it is suggested that one should select, with the help of appropriate support tools, low-cost improvements that can be built into work methods and equipment and are realizable by means of local skills and materials [35-37]. Scott and Charteris emphasized that it is necessary to include both microergonomics (i.e., as a concept of an Ergonomics Stress Index (ESI) [38]), and macroergonomics approaches (i.e., the goal of it is to optimize the work system's design in sociotechnical system characteristics, and then carry the characteristics of the overall work system design down through to the design of individual jobs, human-machine and human-software interfaces to ensure a fully harmonized work system) [39]. Instead of evaluating the performance of two approaches, one needs to acknowledge their complementary interdependence, where the ratio between their inputs will vary according to the situation being addressed [39].

Hendrick and Kleiner noted, when the goal of macroergonomics is achieved, the result should be dramatic improvements in various aspects of organizational performance and effectiveness [3]. This has been shown in the results of ergonomics intervention work at Glucosan factories from 1995 to 1997 [40-42] and also three subsidiary companies in Iranian industries [43,44].

According to Hendrick and Kleiner, macroergonomics is top-down (i.e., strategic approach to analysis), bottom-up (i.e., participatory ergonomics) and middle-out approaches (i.e., focus on processes) [2,3]. Central to macroergonomics is the expectation that analysis and design of work systems will be participatory in nature [45-47]. To achieve human-centered work system designs, human-centered analytical processes must be used. This constitutes the sociotechnical principle of compatibility. Consistent with the emphasis on participation in a number of domains, participatory ergonomics is rapidly emerging as an area of international inquiry in its own right [48] and is seen as a core method in Macroergonomics. Macroergonomics is human-centered [16] and participatory ergonomics is a primary methodology of macroergonomics involving employee's at all organizational levels in the design process [49]. Therefore, it is emphasized that the concept of macroergonomics is human-centered and participatory [7,8].

Robertson noted, when a macroergonomics approach is taken, training is part of a comprehensive, systematic approach to enable knowledge within an organization [50]. But Deming describes a system as a network of interdependent components that work together to try to accomplish the aim of the system [51]. The system begins with an awakening ('an awakening to the crisis' as Deming described it) [52]. The aim of the awakening could be to stress the importance of the need to change. Without an awakening, the person can, at best, learn many important lessons. For example, Helali observed that different participants participated in the ergonomics training workshops between 1996 and 2002 from Iranian industries, or the ergonomics training workshops were conducted at group level for the

Iran Khodro (Car) Company, between 2001 and 2002, or according to implementing "Job Enrichment" with using Ergonomic Checkpoints (ILO, new version 2010, [53]) at a Pharmaceutical Manufacturing Company in 2012 [54]. This resulted in participants learning many lessons. But, deeply motivated intention occurs after the awakening about using the 'Future Workshop' at the organizational level (Helali and Shahnava; Helali) [7,41] and also materialized though employing ILO's "Ergonomic Checkpoints" and appreciating the need for approaching understanding in the deep health, safety, and ergonomics, and the working condition as a whole research in the study of Dastranj and Helali; Helali and Dastranj [54,55].

### The use macroergonomic intervention work in Iran

The ergonomics intervention technique models based on the long research journeys since 1996 by Helali's study could be focused on Ergonomics 'Know-How' (i.e., learning by doing could be characterized as practical knowledge), 'Know-What' (i.e., learning by using could be characterized as strategic understanding), 'Know-Why' (i.e., learning by studying could be characterized as theoretical understanding), 'Know-Who' (i.e., learning by engaging participants to purpose participation and collaboration) [33,34]. For this reason, the participants could be engaged in the recognition of processes and applying different ergonomics interventions-based on levels 'Training' (i.e., training as a learning-performance workshop), 'Learning' (i.e., learning by doing individually and collectively as the Ergonomics Intervention Programme Technique (EIPT) Process) and its 'Meta-reflection' (i.e., 'this is thinking again about our reflection-on-practice. It is stepping back and checking out what we thought and said earlier. It is further removed from the action than "reflection-on-practice" [7,56]. Accordingly, building 'taxonomy knowledge' on the ergonomics intervention work as a product joining up practice with theory could be outlined in Table 1 by Helali as follows [34]:

The activities training and learning were based on using different technologies on the knowledge within organization. For this reason that, knowledge can be purposeful coordination of action. Achieving intended purpose is the sole proof or demonstration of knowledge [57]. Zeleny noted that its quality could be judged from the quality of the outcome (product) or even from the quality of the coordination (process) [57]. Helali has indicated that, ergonomics 'know-what' refers to the knowledge of objects, facts, components and goals from different strategic understanding as 'learning by using' because, Zeleny has noted "what is knowledge?" and also Sanchez has stated "what are three different kinds of knowledge within an organization [33,57,58]. Zeleny emphasized that pragmatic philosophical roots firmly established the knowledge when it was Albert Einstein who cautioned our world "Information is not knowledge" [57]. Thus Einstein also asserted "Knowledge is experience. Everything else is information" [57].

The first result of applying macroergonomics was at the Glucosan Factories between 1995 to 1997 in the manufacturing industries of Iran that it had a positive effect on their production capacity by applying macroergonomics intervention, i.e., a) in which the capacity rose from 70% to 105% of the nominal capacity; b) 'Utilization' of starch from corn was improved by 11%; c) Glucosan factories has achieved to the world best practices production level; d) The quality of the products was improved, reaching international standard, making it possible to be exported; e) An increase of up to 600% in all employee wages through profit sharing; f) Development of a new organizational system for making full use of worker participation; g) This practice was the first sample of applying ergonomics to work system in Iranian industries

Technology		Analogy building 'Ergonomics Intervention Work'	Effect	Purpose
Data	Ergonomics Intervention Programme (EIP)	Elements are 'Actors': Coach, Participants/Students, and also Ergonomics tools	Muddling through	Know-nothing
Information	Ergonomics Intervention Programme Technique (EIPT)	<b>Ergonomics Awareness Building:</b> Ergonomics Training+Ergonomics Application+Evaluation <b>Ergonomics Intervention Programme Technique (EIPT):</b> Ergonomics Awareness Building+Research Activities+Network Building. In addition, Participatory Ergonomics (PE) will improve the intervention success	Efficiency	Know-how; Learning by doing
Knowledge	EIPT process	Coordination the ergonomics intervention technique processes with different useful factors toward the result product	Effectiveness	Know-what; Learning by using
Wisdom	Ergonomics intervention work (EIW)	Why systemic ergonomics interventions work? Why in this way? How can it reframe?	Explicability	Know-why; Learning by studying
Enlightenment	'Appreciative EIW'	Systemic Ergonomics intervention work, clearly	Truth	Know-for- use

Table 1: 'Taxonomy knowledge' on the systemic ergonomics intervention work as a meta-reflection of a product joining up practice with theory.

and was successful at the organizational level so that, after 12 months of macroergonomics intervention at Glucosan factories, the company's profit rose by 390% when there were also Organizational Development (OD) and a learning strategy at Glucosan Factories [7,42].

More than 19 years studies conducted by Helali on the ergonomics intervention work show the necessity of an awakening process and the applying ergonomics to work system in industries of IDCs such as Iran [34]. Consequently, developing vision, ideas and awakening at the organizations to apply ergonomics for improving the work system helps to achieve productivity in the workplaces [7,8,33].

Based on ILO (1996; new version 2010) findings and also, Niu; Helali; Helali and Abdollahpour; Helali and Dastranj; Dastranj and Helali), "Improving Working Conditions Systems" includes development and implementation of programs to improve Health, Safety, and Ergonomics and competence people (both technical and social skills) in the workplaces [43,53-55,59-61].

The purpose of this study therefore was to create macroergonomics awareness and wakefulness at a Manufacturing Company, in order to emphasize the importance of improving "Working Conditions Systems" (Health, Safety, and Ergonomics) and understanding the necessity of the applying ergonomics to work system. It sought to develop vision, ideas and draw up checkpoints for the organization of work where research considers involving both of the company and the participation of participants, not only on people or techniques and tools.

This study was therefore underlined by the following question: "How can a systemic pre-macroergonomics intervention work process, be introduced at the Manufacturing Company, in order to ensure the successful "Awakened need of change" to apply the ergonomics?"

The company focuses on building up the capabilities of the hot section of gas turbine blades in various capacities, as the largest manufacturer of turbine blades used in thermal power plant in Iran is active. It had 738 employees (46 women and 692 men). Inclusion criteria for this study were: (i) Diploma or higher, and (ii) At least one year experience in the relevant units.

## Methods

### Procedure and Material

First research working organized through arranging four meetings (Separately for each member lasting one or two hours each) between the authors and the Heads of the Company's HSE (Health, Safety

and environment) Department, Research and Development (R&D) Department, Human Resources and Logistics Department. Then a final meeting was held with all of them to present finding after conducting the study plan, which lasted up to 2011. Then, the manufacturing company approved the study and aimed to carry it during one year.

The survey approach was used from several steps with different sample participants: including; 1) Studying the three questionnaires which evaluated manager's viewpoint (29 people), health, safety and environment (HSE) employee's viewpoint (5 people), and operating worker's viewpoint (85 people), 2) Using Future Workshop (FW) for middle managers (15 participants), 3) Doing an ergonomics checklist in one of units of the company (29 participants), 4) Evaluating Workshop, with middle managers (15 participants), 5) Interviews with some participants in Future FW (10 participants), 6) Interviews with some participants in using of the checklist (4 participants) and, 7) Review of the organizational documents were used that this survey research describes detail it as follows:

### Questionnaire Survey

First of all, three questionnaires on improving working conditions (three questionnaires for the managers, personnel of HSE department, and operational staff) designed by Chavalitsakulchai (1992; Appendices III to V) to evaluate improving working conditions programme in the industry were used to gather basic information about improvements in working conditions system in the company [62]. Each questionnaire followed a different approach.

In the Questionnaire Survey, the main and independent variable was Improving 'Working Conditions Systems' and the views expressed in the three groups and background variables such as demographic characteristics.

The sampling method used for managers and HSE staff was the census sample method, and the method used for operational employees (Population of 270) was the Cochran (Correlation coefficient 0.3) approach.

To analyze the questionnaires, the primary relation between Chi-square, Pearson, Kruskal Wallis and Mann-Whitney tests were used.

### First Workshop (Future Workshop with introducing Macroergonomics)

Future workshop (FW) based on the Müllert and Jungk (1987) model, has 5 phases, with phases 2, 3, and 4 forming the main parts of the FW [63].

According to Helali and Shahnava (1998), the five phases are defined as follows:

- 1) Preparation phase (i.e. the aim of this phase is to define a clear, short and challenging 'theme' for the workshop, acceptable to all participants) [41].
- 2) Experience phase: Also called 'critic phase' (i.e. this phase aimed to highlight all problems experienced by participants with regards to the workshop's theme. A complete 'problem catalogue' is developed).
- 3) Fantasy phase (i.e. the aim of this phase is to come out of the daily limitations that usually lead to restraint, traditional thinking and acting. Participants have many ideas that have never been expressed or formulated because they are framed in what they believe is right and possible. In the fantasy phase, everything is possible. There are no barriers, no economic, personal, technical or organizational limitations. The idea is to develop future visions).
- 4) Strategy phase (i.e. the aim of this phase is to go through all the written fantasies with the aim of finding all the barriers regarding the realization of the fantasies). Participants have learned to use the different techniques, such as desirability and possibility assessment, the circle model or development model activity, the triangular model, and cause and effect diagram, in order to develop a feasible strategy and solution to the problem on hand at the FW.
- 5) Action phase (i.e. after the workshop, a complete report is prepared containing all the critical problems, and fantasies, as well as the programme/plan proposed by the participants. The report is an idea catalogue for future actions).

This method has also been used in IDCs as an ergonomics tool in studies carried out by, Helali and Shahnava (1998); Sanda (2006); (Helali, et al, (2008) and Helali (2008; 2009) and also see Sanda et al, (2011) the using it further of here as a tool in problem-indentification workshop [7, 8, 41, 44, 64, 65].

The FW was announced through an invitation sent by the training department to all Top and Midlevel Managers of the company, and was held for two days at the conference hall of the company. It was attended by the mid-managers and individuals from different departments of the organization. At the beginning of the FW, some discussions were presented about the necessity of knowing about macroergonomics and participatory ergonomics as its tools in order to provide a correct understanding of the working conditions improvement system and the removal of obstacles as well as developing a working conditions improvement system.

In the first phase of the FW, developing organizational behavior was the first factor contributing to a working conditions improvement system using the macroergonomics approach. Therefore, the FW focused on developing Organizational Behavior (OB). Once the participants agreed with this topic, and the FW would be entered phases 2, 3 and 4.

### **Applying an Ergonomics Checklist on some 'Department'**

A checklist of ergonomics issues presented by the International Labor Office (ILO) and the International Ergonomics Association (IEA) (ILO, 1996 [60]) was used to continue the analysis using the macroergonomics approach after a manager with one of units of the

company taking part in the FW showed interest in this regard. This first version of the book's translated was published to Farsi by Glocosan Factories in 1996.

It is comprised of a checklist, checkpoints on 9 different topics and important principles related to safety, health and ergonomics, including materials storage and handling (21 checkpoints), hand tools (15 checkpoints), machine safety (20 checkpoints), improving workstation design (14 checkpoints), lighting (9 checkpoints), premises (6 checkpoints), environmental hazardous (7 checkpoints), welfare facilities (13 checkpoints), and work organization (23 checkpoints).

Furthermore, a new version ILO (2010) developed for application in both industrial developed and IDCs. This new version also translated to Farsi in 2015 by Dastranj and Helali (2015) as a free edition [53, 66].

The ILO book (version 1996) was used and this was done in a production unit of the company, which had 29 employees, including the chairman, supervisors and operational staff (used census sample method). Seven action groups were formed to implement the checklist: Group 1: Material Storage and Handling, Group 2: Hand Tools, Group 3: Machine Safety, Group 4: Workstation Design, Group 5: Lighting and Premises, Group 6: Welfare facilities, Hazardous substances and agents, and Group 7: Work organization.

In each action group, the organization of work was assigned to supervisors and heads of departments while other tasks were given to ordinary employees. Learning from each other and sharing their experiences in the workplace, the taskforces examined the ergonomics checklists 2 months after they were implemented, and represented their solutions for problems existing in their workplace. Finally, the feasibility and application of all the solutions were evaluated in the presence of all the participants. As well as to assess the ergonomics condition based on the participants' answer to checklist, the ELMERI index was used [67].

### **Second Workshop (Evaluation Workshop)**

Almost five months after using the FW technique, the pre-macroergonomics intervention situation was evaluated at a workshop attended by the participants. The evaluation covered the following question: "after this period of time, what do you think about the existing or future working condition improvement systems as well as the optimization of such systems?" Meanwhile, the company's training department evaluated the effectiveness of the FW independently, determining the level of macroergonomics based on the viewpoint of 15 participants (who had participated voluntarily).

### **Interview with the participants of the First Workshop**

This interview aimed to explore and understand ideas of people as a reflection about Improving 'Working Conditions System' problems after participating in the FW. After explaining the purpose of the interview participants, they voluntarily participated in the interviews (10 participants).

In this stage, the participants were interviewed based on a semi-structural basis (they were asked questions such as "since you have taken part in the FW, how do you evaluate the problems existing in your own company?), in order to better understand the depth of problems with the company's working conditions improvement system. To analyze the results of the interviews, analytical interpretation methods were used.

### Interview with those participating in applying the checklist

After of 2 months from applying the checklist, 4 participants were interviewed on a semi-structural basis (they were asked questions such as “how the application of the checklist to all levels of your organization affected efforts to identify problems with its working condition improvement system?”; “Having applied the checklist to all organizational levels, what do you think is wrong with your company’s working conditions improvement system?”; “How did the utilized approach affect you and your organization? After of interview, for analyze the results, analytical interpretation methods were used.

### Review of the organizational documents

In this stage, monthly and annual reports on HSE department, along with the personnel records of the employees belonging to 2009 and 2010 were surveyed.

## Results

### Results of the Questionnaire Survey

The Demographic and organizational characteristics of questionnaire study population has shown in Table 2.

Based on Table 2, almost of participants were men in the middle managers and the HSE department personnel (respectively 96.6% and 80%). Also the operational staffs of the study population, 100% of the sample were men.

A statistical analysis of the data revealed that the three questionnaires had covered 119 people of the three groups presented in Table 3.

The results of the questionnaire indicate that the three groups taking part in this study had similar ideas on some issues with regard to the working conditions improvement system, and there were no significant differences between them, and there were significant differences between them on some other issues. It is important that the three groups have pledged to participate in efforts to promote the existing working condition improvement system presented in Table 3.

### The Results of the Future Workshop

FW conducted for middle managers 15 participants that Table 4 has shown demographic and organizational characteristics of participants in the FW.

Based on Table 4, the middle managers of the subjects, 86.7% of males and 13.3% were women. The mean age and Job Tenure of participants in FW was, respectively 34 and 3.4 years. Also, many participants (80%) were bachelor level education.

In the FW, in the first phase, which was the preparation phase, the participants mentioned the problem related to organizational behaviour as the most important problem ahead of the working condition improvement system. A total of 83 problems were mentioned by the participants in the experimental phase. Having prioritized the stated problems, the results

were classified under three topics related to the organizational and corporate culture of the company, these topics included:

- Systems, methods and organization (17 items);
- Human resources (Cultural, educational) (13 items);
- Business development, strategy and planning (3 items).

After selecting items for the three above individuals based on their interest and expertise in organizational units, three groups were formed with the above titles for the implementation phase of the fantasy.

33 prioritized problems classified in the experimental phase and moved to the fantasy and strategy phases so as to adopt proper solutions for the problems.

The 33 problems were scored and classified into three groups, including the systems, methods and organization group, human resources group and business development, strategy and planning group. After initial examinations, the groups represented the 4 main problems in the fantasy phase. Finally, solutions offered for the problems, were examined by the three working groups in the strategy phase.

Lack of accountability system and lack of collaborative leadership styles were the two fundamental problems related to organizational behaviour and working condition improvement system discussed by the first group. Regarding the lack of accountability in the company, some mid-level managers stated that unaccountability on the part of different departments contribute to the lower quality of the overall performance of the work system. The second problem (lack of collaborative leadership styles) leads to the failure to use the full capabilities of individuals to improve working conditions.

The second group studied the problem of profit-orientation, which could not be blamed on individuals. This problem is due to the lack of workable systems for improving working conditions, according to the questionnaires and the viewpoints of those taking part in the FW.

The third group examined the problems of the sudden growth of the organization and waste of resources. These problems were represented as important problems ahead of the work system of the company related to improving working conditions, according to interviews with the participants after the workshop.

Results related to the effectiveness of the FW were also studied by the Training Department of the Company, with the effectiveness standing at 78%. After the second day of the workshop, the participants were asked to offer their opinion about being in the process and their understanding of it. The main viewpoints offered by the participants included: 1) To sort out the problems and the related departments; 2) To get better viewpoints on macroergonomics; 3) To learn more about the interaction between individuals and departments; 4) To determine the synergy effects of macroergonomics; 5) To become prospective and identify methods for creating cooperation between managers and employees to solve problems and make better decisions; 6) To secure

Variant	Gender N (%)		Age (year)	Job Tenure (year)		Education N (%)		
	Men	Women	Mean (SD)	Mean (SD)	Diploma	Associate degree	B.Sc.	M.Sc. and above
Managers	1 (3.4)	28 (96.6)	35.2 (4.5)	4.06 (1.9)	1 (3.4)	27 (93.2)	1 (3.4)	-
HSE staff	1 (20)	4 (80)	32.4 (2.9)	3 (1.2)	1 (20)	3 (60)	1 (20)	-
Workers	-	85 (100)	26.6 (2.4)	3.6 (2.5)	-	-	32 (37.6)	53 (62.4)

SD; Standard Deviation

Table 2: Demographic and organizational characteristics of questionnaire study population.

Viewpoint The most important item on	Managers	HSE staff	workers	Chi-squared test (P-value)			Kruskal - Wallis test (P-value)	Man Whitney (P-value)		
				Managers and HSE staff	HSE staff and workers	Managers and workers		Managers and workers	HSE staff and workers	Managers and HSE staff
The goals of improving working conditions programme	Improving working condition (Health, Safety, and Ergonomics)			>0.05	>0.05	>0.05	>0.05			
The person or group responsible for setting goals of improving working conditions programme	Senior management	Senior management	HSE staff	Most options >0.05	Most options >0.05	Some of the options <0.05 and others options >0.05	<0.05	>0.05	>0.05	<0.05
The person or group decides on policy of improving working conditions programme	Senior management	Senior management and HSE staff	All three groups (Managers, HSE staff and workers)	Most options >0.05	Most options >0.05	Some of the and <0.05 options others options >0.05	<0.05	>0.05	<0.05	<0.05
The person or group initiated a specific case for improving working conditions	Management unit	Head of Unit, HSE staff Safety Committee,	Head of Unit	Most options >0.05	Some of the and options <0.05 others options >0.05	Some of the and <0.05 options others options >0.05	<0.05	<0.05	<0.05	<0.05
The person or group responsible for identifying problems related to the improvement of working conditions	HSE staff	Safety Committee	HSE staff and workers	Some of the options <0.05 and others options >0.05			<0.05	>0.05	<0.05	<0.05
The person or group responsible for proposing recommendations for improving working conditions	HSE staff Safety Committee	Management unit, HSE staff	workers	>0.05	Most options >0.05	Some of the <0.05 options and others options >0.05	<0.05	>0.05	>0.05	<0.05
The person or group responsible decision for improving working conditions	Senior management	Senior management	Management unit	>0.05	Most options >0.05	Most options >0.05	<0.05	>0.05	<0.05	<0.05
The person or group responsible for implementation recommendations to improve working conditions	Senior management, Head of Unit And HSE staff	Management unit, HSE staff	Head of Unit	>0.05	Most options >0.05	Most options >0.05	<0.05	>0.05	<0.05	<0.05
Methods for the promotion of improving working conditions programme	Increased knowledge regarding the identification of problems of working condition	Greater participation between three groups Further, support for management, Implementing an appropriate intervention	Greater participation between three groups	Most options >0.05	Most options >0.05	Most options >0.05	>0.05			

**Table 3:** The results of the questionnaire responses of the three groups about improving working conditions programme in the target company.

Variant	Gender		Age (year)	Job tenure (year)	Education N (%)		
	Men	Women	Mean (SD)	Mean (SD)	Associate degree	B.Sc.	M.Sc. and above
	13 (86.7)	2 (13.3)	34 (4.1)	3.7 (1.6)	1 (6.7)	12 (80)	2 (13.3)

\*SD: Standard Deviation

**Table 4:** Demographic and organizational characteristics of participants in future workshop.

brainstorming in identifying and solving work problems; 7) To cause fundamental shifts in thinking about the concept of ergonomics; 8) To find ways to create interaction between employees and work systems; 9) To determine the impacts of any failure in part of the system on the whole work system; 10) To study macroergonomics in relation to human interactions with the systems; 11) To determine different tasks in solving work problems; and 12) To understand of micro- and macroergonomics comprehensively.

### Results related to applying the checklist to some departments

The demographic and organizational characteristic of participants in using the checklist has shown in Table 5.

Results related to the application of ILO ergonomics principles checklist to one department of the company by the 7 action groups have showed that out of the 128 questions on the checklist (ILO [60]), 68 questions pointed to problematic issues and 60 questions referred to desirable issues. The ergonomics conditions for problematic working environments were mentioned in category 3 of the checklist selection guide (Laitinen et al.,) based on the ELMERI index, the issue needs to be explored and solutions for improving the situation should be developed in the future in addition to focusing on the priorities. It should be noted that, with regard to the ergonomics problems observed in the department, 47 ergonomics solutions to improve working conditions were presented by the action groups (Figures 1 and 2).

Variant	Gender		Age (year)	Job tenure (year)	Education N (%)		
	Men	Woman	Mean (SD)	Mean (SD)	Diploma	Associate degree	B.Sc.
	29 (100)	-	28.9 (2.6)	3.3 (1.4)	22 (75.9)	6 (20.7)	1 (3.4)

Table 5: Demographic and organizational characteristics of participants in the checklist.



Figure 1: Pictures before and after press machine width reduction to improve poor postures while working.

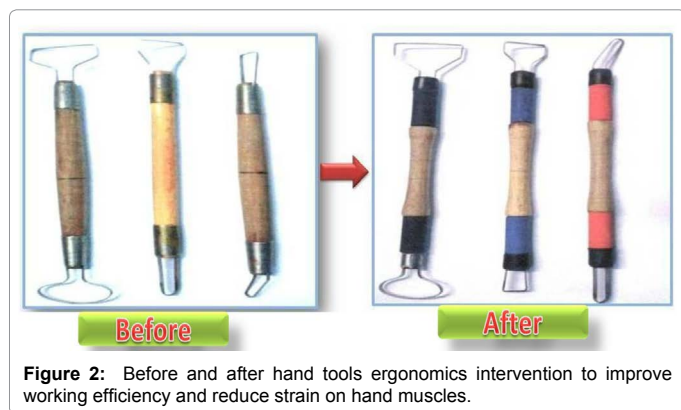


Figure 2: Before and after hand tools ergonomics intervention to improve working efficiency and reduce strain on hand muscles.

Based on the Figure 2, diameter and pinch point of Hand tools redesigned for operators' health and performance. The main ergonomics solutions that offered by the action groups are presented in Table 6.

### The results of the evaluation workshop

In this evaluation workshop, the participants expressed the company's main problem in operating systems and the lack of appropriate interaction between different departments of the company as well as the lack of proper work systems, which have led to a lot of problems (such as delays in implementing solutions to improve working conditions, poor cooperation between different departments in implementing the solutions, and the lack of such interaction), and noted that these problems result in the lack of proper solutions to improve working conditions.

In addition, the head of the related department who voluntarily allowed the implementation of the ergonomics checklist in his department, has presented results concerning the implementation of the ergonomics checklist in a report on the evaluation of the FW's effectiveness and offered relevant evidences presented by the action groups within two working months, emphasizing 47 ergonomics solutions due to their usefulness both in micro and macroergonomics levels, as well as their differentiation and positive organizational interaction (Table 6).

The survey of this workshop showed that participants emphasize and confirm the effectiveness the cases of the result of the learning by using of the FW again after five months.

### Results related to interviews with the participants of the future workshop

Results related to interviews with mid-level managers participating in the FW are presented in Table 7. The interviews were conducted five months after the FW.

### The results of interviews with those participating in applying the checklist

The results of interviews with participants involved in applying the checklist of Ergonomics Checkpoints (ILO [60]) are presented and interpretation on requirements them in Table 8.

### Results related to the review of the organizational documents

Records of absence from work, taken from organizational documents, and the prevalence rate of musculoskeletal disorders among the workers are seen in Figure 3. Based on Figure 3, most of the employees were suffering from low back and knee problems. The poor postures of workers in the production line are indicative of the poor performance of the company's working condition improvement system (Health, safety, and Ergonomics). The percentage of each musculoskeletal problem that made employees quit their job last year is as follows: neck (13%), shoulder (7.4%), elbow (0%), upper back (3.7%), low back (38.9%), wrist/hand (5.6%), hip/tight (5.6%), knee (11%), ankle (7.4%), feet (7.4%).

Furthermore, the workers were absent from work for 1819 days due to occupational diseases in 2010, up 36.5% compared to the 1333 days in 2009.

### Discussion

The results and relevant interpretation are discussed from the perspectives of the following 'the definition of a phase method systemic pre-macroergonomic intervention work for 'awakened need of change'', 'A model on getting the different levels of learning', and 'its meta-reflection on' as follows:

As it is shown in Figure 4, a frame has been designed to define the systemic pre-macroergonomics intervention work process prior to using different macroergonomics methods on the learning levels. This is a concept of empowerment as process [62-68]. Based on the empirical evidences from this study, integrating the aforementioned factors coupled with the creation of a team of facilitators (the authors were the internal and external facilitators), resulted in the purpose of this study for the awakened need to change to apply ergonomics to work system. The key findings were made through intentional learning on how the middle managers with the macroergonomics attitudes as 'Top-down' (i.e., strategic approaches to analysis from the three questionnaires survey), 'Middle-out' (i.e., focus on the process of using FW) and 'Bottom-up' (i.e., participatory ergonomics of using the ergonomic checkpoints), the participants could be empowered in the different cycles of learning, based on the interactive approach used the systemic pre-macroergonomics intervention work.



Technical area	Problems identified in workplace	Number of solutions	Main solutions offered by action groups
Materials storage and handling	13	6	Using of lift jack, Reduce the height of the shelves, Hand placement on cartons, using of mechanical devices, Locate suitable for emergency exit doors
Hand tools	8	8	Use mechanical or hydraulic arm to keep and carry blades, Reduction tool diameter, Use plastic coatings on tools to easily work with them
Machine safety	3	3	Machinery safety training to new workers, Regular inspections of electrical cables
Improving workstation design	12	11	Put the equipment used at the proper height, Wide Working desks, Adjustable some work tables, Removing obstacles from workstations, Cleaning wax from the insertion site templates, Change in design of handling manipulator for easier access, the use of mobile manipulator, Design round table with adjustable height Increasing the number of light sources,
Lighting	4	4	Use dark plates for less glare, Regular cleaning of light sources
Premises	4	3	The use of thermal isolation, Installation of local exhaust ventilation, Cleaning ventilation valves
Control of hazardous substances and agents	4	1	Training employees about the risks of hazardous chemical agents
Welfare facilities	9	3	Improve the locker rooms, Training on the proper use of personal protective equipment, Appoint a person to clean the work area at the end of each work shift
Work organization	11	8	Talking to staff to use their ideas and creativity, Increased score and reward personnel for their contribution to the improvement of working conditions, Deliver results to their workers When grading their work, Increase training time and New training, Using other companies' experiences
Total	68	47	

Table 6: Main solutions offered by action groups.

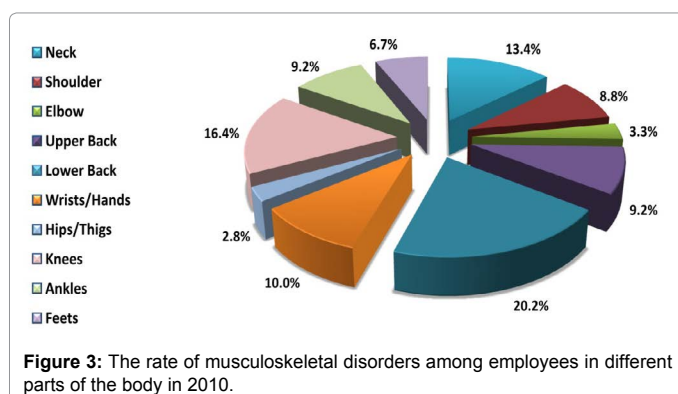


Figure 3: The rate of musculoskeletal disorders among employees in different parts of the body in 2010.

The findings in this study are signified by PDSA Cycles of learning introduced by Deming [51]. Accordingly, the notion of open system theory has played a crucial role in the study of organizations; for example, the sociotechnical theory is heavily influenced by the systems theory. It is usually also referred as macroergonomics [3]. Action however, must be managed by different learning levels (Figure 5), this could be accomplished through a Plan-Do-Study-Act (PDSA) cycle [51]; i.e., the PDSA cycle describes a method of continuous improvement. First, the problem is identified and a subsequent solution is found (Plan). Then the solution is applied with the hope that it eliminates the problem (Do). After this, the result of the activities is investigated (Study). The last phase is to establish the result in the organization to see if the result is satisfactory, and gives feedback to other interested parties (Act). This cycle is a flow diagram for learning, as well as for improvement of a product or of a process. Additionally, learning must be continual. The only way to continue the transformation is to obtain feedback and to reflect [69], and then to repeat the loop to different purpose learning levels

(Figure 5) with a "Meta-Reflection" when we will go further of here as an "empowerment as a way of thinking" [33,59,68].

Therefore, based on the design of this kind of work by the second author, a study has been implemented in one of Iranian industries in 2010 by the authors as a successful interactive research work [59,70].

The model could be characterized based on understanding the organizational knowledge on the systemic pre-macroergonomics intervention work at the company with the different getting learning understanding when there are the different concepts of "learning" and its meta-reflection in Figure 5 as follows:

The first cycle of the research survey on the organizational knowledge was 'know-why' as theoretical understanding or learning by studying for the awakened need of change. For this reason, we were used the three different questionnaires survey to managers, HSE (Health, Safety, and Environment) department personnel and operational staff that it could be used to gather basic information about the improving working condition system status of each company from three views of organizational levels. This could show us one kind of empowerment as a way of thinking on the company when we use example Chavalitsakulchai's questionnaires that it was designed in 1992 and we could apply and analyze statistically it to propose where company is standing for improving working condition system as follows:

All the three groups (managers, HSE department personnel, and operational staff) have realized the importance of improving working conditions (health, safety and ergonomics).

Improving working conditions and offering solutions for health, safety, and ergonomics problems were the main goal behind developing the working conditions improvement program. According to the results of the Chi-square and Kruskal Wallis correlation test, there was no significant difference between the viewpoints of the three groups.

N	The stated common opinion	Explains	Interpretation on requirements
1	Performing independently from the whole organization	This means that each of the various departments of the company sought to achieve its own specific objectives rather than contributing to achieving the objectives of other units and the whole organization. As a result, the interaction between the units was limited and was not sufficient, and the objectives of the working conditions improvement programs progressed slowly, or the programs could not be supported by all levels of the organization	Improvement of skills, practices and performance; because of solely focusing on individual performance rather than the performance of the whole system to make significant differences
2	Lack of sophistication	Means insufficient cooperation among people and lack of required vocational skills on their part	Learning from each other and the visible development of all of those involved.
3	Inappropriate interaction among the departments	It means that there is poor interaction among the departments and that customers are not respected sufficiently	Task & people level: Socio-technical approach which both technical and human-centered approaches are Acknowledged and merged together in the social & technical approach.
4	Abnormal and unplanned development is the main reason behind all the problems existing in the company	This means that, the staff always has high levels of stress at work, because they are not ready and are not aligned with the requirements; and do not have the potential to make changes and move toward development. As a result, they are exposed to instability and loss of job. Organizational documents indicate hiring young staff is the best solution to the problem, but loss of financial and human resources were still one of the main concerns of the director in the initial meeting. He stated: "we are losing our skilled workforce and that is problematic. So we need the ergonomics.	Management & Leadership contributes to making changes (applying Macroergonomics)
5	There is no workable system in the company. Variable methods such as EFQM, ISO 14000, and OHSAS18001 and 5s are used of course, but the system is not comprehensive and the methods have not been implemented correctly and fully. So there are some problems in the company such as insufficient cooperation on the part of department staff	This means that the lack of staff involvement and cooperation in implementing these systems is one of the main reasons behind using flawed methods. Usually, training is provided to individuals regardless of their duties. Due to such negligence, problems such as the lack of interactions between the enterprise and the staff, lack of practical learning and failure to localize the methods are observed	Participatory Ergonomics and Practitioners' commitment toward working with people ethically
6	Poor planning due to poor job descriptions which do not define the duties and responsibilities clearly	This means that work expectations are not clear, especially with regard to mid-level managers, employees are confused and suffer from stress, something that interfere with the progress of work, organizational commitment and motivation.	Work systems should be modified
7	Lack of proper planning at the macro level and lack of relevant details, as well as lack of proper information on the annual programs of the departments. As a result, programs are not implemented properly and expectations are not met	This means that the process of work in the company has not been organized and does not respond in a dynamic way	Ideas or actions, including middle-out (i.e., focus on processes), top-down (i.e., strategic approach to analysis), and bottom-up (i.e. participatory ergonomics.
8	The organization is facing many problems due to the independence of work systems, doing jobs in cross-sectional ways, and lack of proper communication between the departments	Means parallel work, waste of resources, and so on	Commitment to learning and change
9	Poor cooperation causes low participation in both higher and lower levels. In case of participation, it will be due to pressure (sectional) exerted by the management or due to non-formal relations among some individuals in some departments	It means that the manager should direct informal relationships toward work-related relations, so that a formal organization acceptable by the staff will be designed and implemented	This also requires proper macroergonomics intervention programs
10	Employee commitment and motivation decline day by day due to paying little attention to the lower staff, particularly operators and technicians, and paying too much attention to mid-level managers and directors who are rewarded with bonuses.	It means that there is little commitment toward learning, organizing and making positive changes	Using participatory ergonomics in the company is necessary

**Table 7:** Results related to interviews with mid-level managers and relevant interpretations.

It is noteworthy that, according to the viewpoints of the three groups, group solidarity does not play an important role in improving working conditions, something that is regarded as a weakness. Hendrick stated that interactions among different departments would be improved if the macroergonomics approach used beside the human-machine and human-software interactions at the micro level [15]. This conclusion is clearly evident in the results of studies on Glucosan Factories by Helali and Shahnava, and the results of studies on the Iranian industries by Helali et al.; Helali and also Shahnava et al. [42-44,71].

Based on the viewpoints of the personnel of the HSE department, their working goals contribute to improving working conditions in the company.

Preservation and maintenance of labour at each working environment is the most important objective of the HSE department (Table 3).

According to viewpoints the managers and HSE staff, the top management is responsible for setting goals for the working conditions improvement program. The employees believe that the supervisor of the HSE department should be assigned to do this job. The results show that the three groups taking part in the study had no idea who was responsible for the aforementioned task (Table 3). As for the macroergonomics concept [2,3], the interaction must be a two-way or multi-way one, so that it could lead to synergistic cooperation and better results.

N	The stated common opinion	Explains	Interpretation on requirements
1	Practical acquaintance with ergonomics took place when we got involved in the identification process through the checklist and provided practical and inexpensive solutions	It means that problems were identified, practically because we began to learn from each other	More action learning is needed in order to solve ergonomics problems
2	Better interaction was observed among the staff, supervisors and mid-level managers with regard to offering innovative and creative ways to identify problems and provide appropriate solutions after the taskforces became cooperative.	It means that better interactions were observed among different levels of the organization with regard to identifying problems after they all were involved in the process. Previously, there was no such interaction in the company with regard to using appropriate ergonomics tools.	Macroergonomics approach should be used in the company in order to involve all levels in ergonomics interventions
3	Involving all levels of the organization in the process of identifying problems and providing convenient and inexpensive solutions to improve the working conditions of the departments led to a better interaction between different departments of the company.	It means that it will lead to better interaction among different departments in identifying and solving problems	The Macroergonomics approach, especially the participatory ergonomics, should be employed in the company in order to improve work systems
4	The employees were motivated to Identify problems and offer solutions so as to make managers realize the important role of the employees in improving working conditions.	It means that the employees should interact with each other using all potentials of the different levels of the organization in order to show their creativity and innovation.	Using participatory ergonomics is necessary

Table 8: Results related to interviews with those participating in applying the checklist.

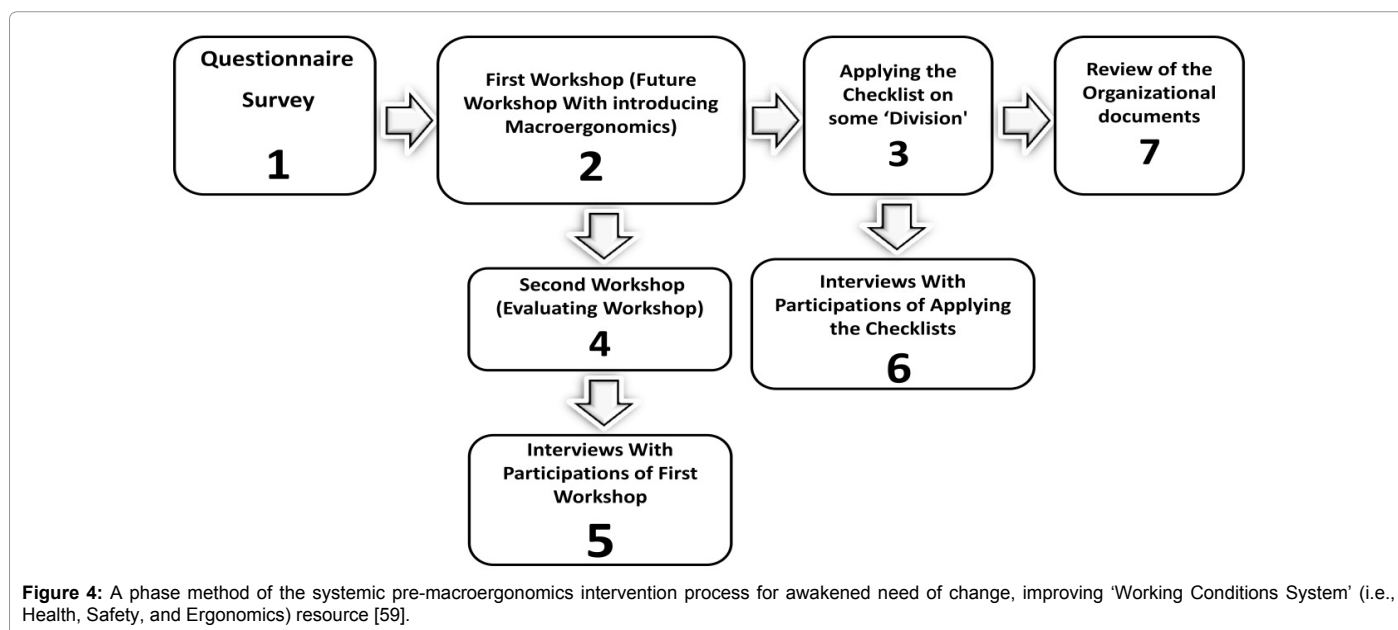


Figure 4: A phase method of the systemic pre-macroergonomics intervention process for awakened need of change, improving 'Working Conditions System' (i.e., Health, Safety, and Ergonomics) resource [59].

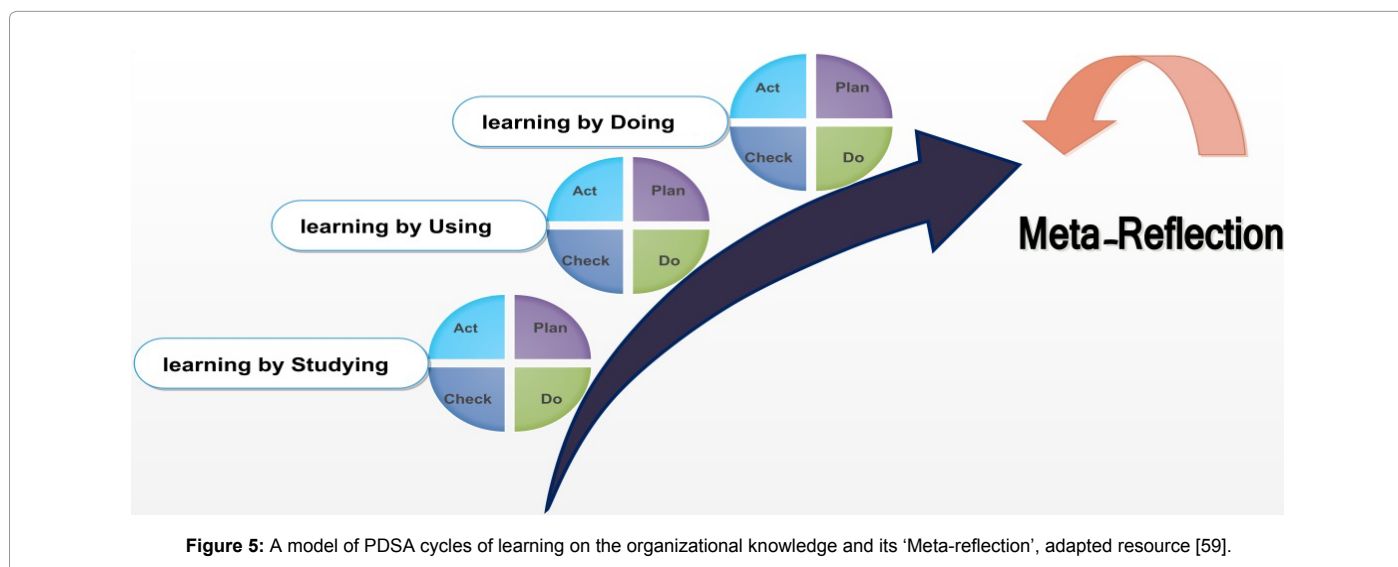


Figure 5: A model of PDSA cycles of learning on the organizational knowledge and its 'Meta-reflection', adapted resource [59].

Based on the viewpoint of the management, the personnel of the HSE department, the manager and supervisor of each department should be in charge of setting goals for the working conditions development program. The personnel of the HSE department believed that this responsibility should go to the safety committee. The results show a significant difference between the three groups in this regard. As for the results of the Chi-square correlation test, the three groups attach little importance to the role of inter-group interaction in identifying problems related to the working conditions improvement program (Table 3). Interviews with the operational workers showed that they were more motivated to cooperate in identifying problems because they believe they face with the problems and can better help identify them. According to the policies of the company's working conditions improvement program, the employees are of little importance. Imada has noted that employee participation plays a major role in improving working conditions [72].

According to the management, the personnel of the HSE department and the safety committee are in charge of the working conditions improvement program. The personnel of the HSE department believed that this responsibility should go to the manager of each department and the personnel of the HSE department. The workers believed that such a responsibility should go to the workers. Regarding the results of the Chi-square correlation test, there was a significant difference between the managers and workers in this regard. Based on the Kruskal-Wallis and Man-Whitney tests, there was a significant difference between the average answers provided by the two groups of managers and employees. The managers and the HSE department personnel believed that the workers plays little role in presenting solutions to improve working conditions, because they themselves are to blame for the related problems. It is noteworthy that the three groups attached little importance to the role of interaction among themselves in improving working conditions, something that could be blamed on the lack of proper working systems (Table 3). On the other hand, the literature of macroergonomics shows that all available resources in the organization should be used in order to increase the accuracy of the measurements and contribute to employee motivation and commitment [3].

The three groups emphasized the role of the manager of each department and the personnel of the HSE department in improving working conditions. According to the Kruskal-Wallis and Man Whitney tests, the average answers provided by the managers, workers, and the personnel of the HSE department showed a significant difference between the three groups. It indicates that there has been little interaction among these groups (Table 3).

In addition, enhancing knowledge to identify problems is an important factor that contributes to improving working conditions, according to the three groups. It indicates the need for extra-organizational scientific support to improve working conditions. Also, the three groups believed that support from the top manager also contributes to the success of the working conditions improvement program.

Regarding the results of the Chi-square correlation test, there was no significant difference between the three groups in terms of ideas, but there was a significant difference between them with regard to the use of better interactive methods.

According to this study, lack of a proper work system in the company under study has led to problems such as insufficient cooperation among different levels of the organization, independent

performance of different departments, poor interactions among the departments, lack of a constant working conditions improvement program, and slow improvements and reforms.

Tables 7 and 8 imply that the organization of work in the company is not appropriate and should be revised. They also show the importance of organizational planning and correct management coupled with cooperation among all levels of the organization. The need for using macroergonomics and making suitable interventions in the company are the other things that could be construed from the above-mentioned tables.

The second cycles of the research survey on the organizational knowledge was 'know-what' as strategic understanding or learning by using for the awakened need of change. For this reason, there are three kinds of the strategic understanding for building ergonomics intervention techniques that were noted by the Helali's study in 2012 [33]. However, there are two different research questions here: 1) How can vision and ideas be developed for applying ergonomics to work system in the company with a middle-out macroergonomics intervention; and 2) What are new checkpoints of work organizations. This could show us one kind of empowerment as a process. Consequently, we could use Future Workshop (FW) based on the Müllert and Jungk model [63]. Before that, it has been used and tested as an ergonomics tool in the IDC since 1996 as mentioned [41]. Here the focus is on the second learning cycles (Figure 4) that all middle-managers of the company must be participated in FW. Because of turnover the change of top managers is high in the IDC's industries. However, the middle-managers have more support role implementing each positive plan and planning.

For this reason, Hendrick and Kleiner noted that Middle-out, an analysis of subsystems and work process can be assessed both up and down the hierarchy from intermediate levels, and changes are made to ensure a harmonized work system design [3].

Awakened need of change has shown that the awakening will be motivated by dissatisfaction with the current state and/or the vision of the future state should the current approach to management and leadership remain [69]. The aim of the awakening is planning for change was the most important issue indicating dissatisfaction with the present state and articulating a desired future. The planning process involved participants from all levels of the organization rather than relying on a single entity or group [51].

According to the findings, the participants showed a kind of awakened need of change after attending the FW and presenting feedback for the learning of each other after five months. It also should be noted that two of the midlevel managers who took part in the FW have changed their approach to the participatory ergonomics approach, which means the involvement of the staff and interactions in the department. Also, the results of the questionnaires, the FW, and applying of the checklist show that all personnel of the company from all levels are not involved in the working condition improvement system, something that led to more absence from work due to occupational and musculoskeletal disorders during the two-year period covered by the study. It also led to doing tasks slowly and little cooperation among different levels of the organization with regard to improving working conditions. To solve these problems, it is necessary to apply changes to the working condition improvement system and review ergonomics. These points could be taken into consideration by Top Managers understanding and also, using the participatory ergonomics intervention method.

The participants in the FW (middle managers) emphasized the fact that the desire for change process should also be observed among the top management, so that the organization could implement the proper intervention process for improving the working conditions through the top management's full support. It should be noted that the continuation of the process requires full implementation of macroergonomics intervention such as the ergonomics intervention program technique process model employed by Helali's [7], which emphasizes the importance of practical learning and full realization of macroergonomics attitudes toward applying ergonomics to the work system [2,3].

The third cycles of the research survey on the organizational knowledge was 'know-how' as practical understanding or learning by doing, for the awakened need of change. Accordingly, there are different doing of ergonomics intervention techniques that Helali has shown that how step by step an ergonomics intervention technique and its developing could be formed and studied in an IDC [7,8,34]. In this process, one of the main contributions of the participatory ergonomics process was, using the ergonomic checkpoints [7,53,60,73]. For this reason, the using ILO's book which is based on an action learning or participant engagement by doing helps participants to see integrating "Health, Safety, and Ergonomics" at the workplace as well as one kind of job enrichment based on ergonomics principles and finding new checkpoints. In this study, the ergonomics problems observed in the department, 47 ergonomics solutions to improve working conditions were presented by the action groups. For this reason that, the action-checklist of the ergonomic checkpoints helped to organization that the participants discuss and use it in some divisions till they see and take a whole picture of health, safety, and ergonomics problems in the workplace as one kind of collective empowerment [43,54].

Following this study, the participants took part in the systemic pre-macroergonomics intervention based on the Figures 4 and 5, so as to better understand the work system and macroergonomics reach the awakened need of change stage. In this way, full support of the top manager is necessary in implementing ergonomics 'know-how' transfer management to enhance human working for sustainable improvements in the industry sector of IDCs such as Iran [33].

A Meta-reflection; this research could be in an 'appreciative way', i.e., research with company and the participation of the participants, not only on people or techniques and tools. For this reason, this could be 'empowerment through reflection', i.e., "empowerment as a process", "Empowerment as a discourse", "empowerment as a way of thinking", and also "collective empowerment" for the awakened need of change to apply ergonomics to work system [68].

The practical applications and implications of the systemic pre-macroergonomics intervention are drawn from the finding of the framing positive question. The appreciative reflection is a new form of reflection and it has shown four basic types of appreciative intent toward, knowing, relating, action, and organizing [33,74]. This is one kind of appreciative work system or an appreciative systemic macroergonomics work completely when the purpose could be empowerment through reflection on the awakened need of change to apply ergonomics to work system further of here and, its meta-reflection as "maximizing strategy" (recognizing when an amplification of the 'success' is necessary; including, appreciative inquiries and root cause of success). This can be concluded as follows:

- **Knowing: What could be the successful of this kind of systemic pre-macroergonomics intervention right now? (Appreciative):** Some inquiries and concepts in an action

pathway ergonomics intervention journey in the IDC and this paper for knowing are significant now: "What will the awakened need of change be we want more of here?" (i.e., Appreciative innovating) and "How can we amplify this? As well as how does the future unfold an appreciation of the positive present?" (i.e., reflection learning and action), or "How will we go further here?" (i.e., leading through appreciative). Therefore, this noted that appreciative inquiry and appreciative intelligence are considering something that is looking towards a better future, not necessarily what is wrong [7,33].

- **Relating: What did we need to change to make a better future? (Imagine):** Based on the Work System Sub-Systems study, Figure 6 can be a conceptual model of "Awakened Need of Change" for an Appreciative Work System. This is also indicated as the key characteristic of the sociotechnical system components identified by Kleiner [75].
- **Action: How did we do this? (Design):** This is toward a kind of ergonomics intervention-type action research or reflection learning and action [7,33,76], for this reason, totally, it is mentioned that Participatory and Appreciative Action Research (PAAR) are the third kind of action research about: 1) Using the power of the positive question; 2) Amplifying the core positive question not 'problem solving'; 3) Leading by valuing, not evaluating; 4) 'Appreciative Intelligence' (multiple intelligence); i.e., the ability to see the mighty oak in the acorn, and look at all successful things; 5) 're-framing' (i.e., how one can amplify those things that will help a better future emerging from positive present) by choice not one and best way for doing, or seeing how the future unfolds the present [76]. This can be with focus on the following sub-research questions that it can be formulated as "What are your workplace stories", "journeys", "cultures" and "ballets (i.e., dances)" about applying ergonomics to work system and how you want to amplify it?
- **Organizing: Who took action and with what consequences? (Act):** In the appreciative way, the role of people/participants are to engage in the appreciate path to ask and reply to the

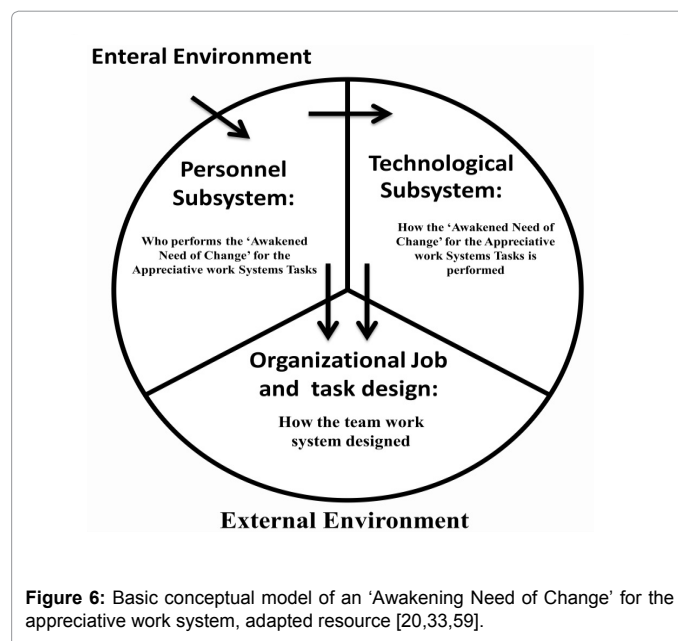


Figure 6: Basic conceptual model of an 'Awakening Need of Change' for the appreciative work system, adapted resource [20,33,59].

reflective questions and also what can they learn from each other and services end-users' experience? This requires the applying ergonomics and Human Factors to work systems in IDCs in an appreciative way completely [33].

## Conclusion

Factors which contributed to the success of this research for identify the awakened need to change from understanding of the applying ergonomics to work system include the following: 1) Learning by studying (Example here, which materialized through employing the three questionnaires survey, evaluation of the three groups of all organizational levels for appreciating the need for approaching understanding the improving working conditions programme); 2) Learning by using (e.g., which materialized through the use of the FW technique for midlevel managers to develop vision and ideas and also find new checkpoints for work organization and work system); 3) Learning by doing (Example here, which materialized through performing the ILOs' ergonomic checkpoints review principles checklist in an organizational unit to get a full image of health, safety and ergonomics in the workplace); 4) Learning of reflection (by interviews as the positive feedbacks from the participants); and 5) Its meta-reflection as "maximizing strategy" (recognizing when an amplification of the 'success' is necessary; including, appreciative inquiries and root cause of success) could be formulated and introduced.

It is a necessity that such applicable research will be financially supported by industrial managers and health policymakers in IDCs' Industries and also ICS' Industries that the awakened need to change to apply ergonomics and human factors to work system is further understood to contribute and considerate of the integrating "Ergonomics, Health, and Safety" at the workplaces and also, the identifying and developing appreciative work system in the organizations when it will be undertaken with the maximizing strategy approach.

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