

Economic Effectiveness of Ergonomics Interventions

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KEYWORDS

*Ergonomics;
Economics;
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product design.*

ABSTRACT

This review article attempts to explore the economic effectiveness of ergonomics. In this review, PubMed, EBSCO, and Web of Science were selected to find the related articles based on two keywords of ‘ergonomics’ and ‘economics’. Eleven full-text articles (1 in PubMed, 8 in EBSCO, and 2 in Web.Sci.) were included in the study. Articles show that ergonomics interventions have an association with economy and productivity; however, 3 out of 11 articles did not show a clear interconnection between ergonomics and economic benefits. All of the reviewed articles were conducted at workplaces and, also, were related to occupational ergonomics; however, in a single case, the ergonomics product design was reflected as a cost-benefit approach. The role of a healthy workforce and ergonomics design with regard to both employees’ efficiency and business growth is often neglected. According to reviewed papers, the role of ergonomics in green economics toward sustainability is inevitable. However, there are some challenges to persuade the industrial sectors’ managers about the economics side of ergonomics in which limited documents and the lack of ergonomics-economics models and procedures are critical. This review emphasized at least two approaches: (1) the necessity of publishing papers, including valid economics model about industrial ergonomics; (2) developing some economic tools to confirm the benefits of ergonomic product design. If some appropriate economic models or techniques merge into ergonomics intervention projects, whether industrial ergonomics or product design, more feasible and better outcomes will be obtained in which both employees and customers are satisfied.

1. Introduction

Ergonomics as a multi-disciplinary science aims to modify, design, and improve the workplace conditions, product, and quality of life. Industrial ergonomics emphasized workplace design for the workers considering personnel performance improvement [1,2,3,4]. However, there are other aspects of ergonomics in which human beings as end users of the products are studied [5]. According to IEA (2007), ergonomics assesses the interaction of humans with the working systems and introduces some theoretical and practical designs for human well-being promotion and overall system performance [6]. Ergonomics was mainly introduced in the Second World War to modify the performance of bomber pilots [7, 8]; however, despite not too long history, it has been developing, plentiful, in which several aspects of human being are considered. Occupational health and safety, tools, machinery and furniture design, better employee performance, and work-environment assessment are some of the ergonomics aspects [9].

Ergonomics has some sub-branches such as micro-ergonomics, macro-ergonomics, and cognitive, environmental, and cultural ergonomics [10]. Micro-ergonomics concerns physical adaptation of workstations, tools, and products to human. Macro-ergonomics studies work system and socio-technical aspects of work systems [11,12]. Environmental ergonomics deals with some physical factors, i.e., illumination, noise, and heat stress. In cognitive ergonomics issue, the perception process of human is assessed. Social and cultural aspects of users' requirements are considered by cultural ergonomics.

Ergonomics is a human-centered science [1,2,13], in which both aspects of somatic and mental characteristics of human are focused. Ergonomics emphasizes health and productivity. Health promotion targeted by ergonomics makes some economic benefits. Undoubtedly, occupational health promotion to minimize the work musculoskeletal disorders (WMSDs) will decrease the costs; otherwise, ergonomic workstations not only control the disorders, but also encourage the workers to do their tasks efficiently [14,15]. In this regard, there is an association between ergonomics and economy

[16]. A study on an electronics company in Malaysia confirmed a 580\$ achievement per year based on an ergonomic interventional program [6]. One of the main objectives of employers is to improve productivity, activities, and competitiveness [17]. In this regard, workers' knowledge improvement about productivity is also a key point [18]. In this review study, the relationship between ergonomics and economics was focused.

2. Methods

In this review study, on the basis of the objective, keywords of "ergonomics" and "economics" were chosen using the electronic search engines such as PubMed, EBSCO, and Web of Science. Last-ten-year history and English language were the limiting criteria in all search engines.

Initially, 344 peer-reviewed articles were identified (7 in PubMed, 307 in EBSCO, and 30 in Web of Science). Non-English papers, reviews, ergonomic task analysis methods, and macro-economic models were removed as the exclusion criteria. By the first screening of related titles, 65 abstracts were selected and read (2 articles in PubMed, 38 in EBSCO, and 8 in Web of Science). As Figure (1) shows, 11 full-text articles were finally selected to critically review.

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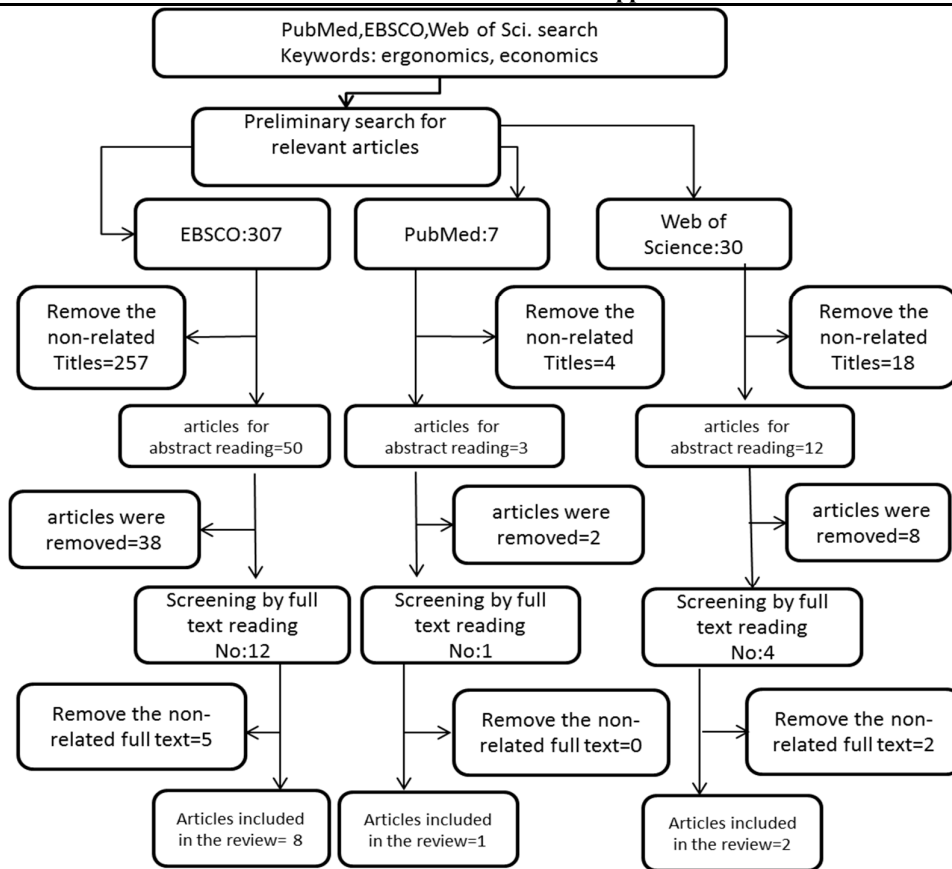


Fig. 1. Hierarchical articles screening in three search engines and two keywords

3. Results:

Table 1 shows the initial sources' numbers of each word of "ergonomics" and "economics" in the search engines as a "title" in PubMed (708, 21819), EBSCO (1280, 169), and Web.of.Sci. (1408, 12340), respectively. In addition, the numbers of sources for the above-mentioned keywords in "topic" were observed in PubMed (1819, 8356), EBSCO (9826, 3798), and Web.of.Sci. (6758, 59842), respectively. However, the numbers of papers including both of ergonomics and economy dropped to around 344. Meanwhile, economic issues in the Web of

Science core collection are about 15 times more than EBSCO; however, the papers that cover both ergonomics and economics are considerable at EBSCO than Web.Sci, and PubMed. Moreover, a comparison between the numbers of articles about ergonomics in EBSCO and PubMed shows that the mentioned issues in EBSCO are about 4 times more than PubMed. It may be shown that, during the last decade, ergonomic issues are considered as a technical issue than medical perspectives; of course, the mentioned results require more evaluation to be more validly conclusive.

Tab. 1. The number of articles among three search engines based on two keywords of ergonomics & economy

	Search engines					
	PubMed		EBSCO		Web.Sci.	
	The initial number of papers without any limitation					
Keyword	<i>Title</i>	<i>Topic</i>	<i>Title</i>	<i>Topic</i>	<i>Title</i>	<i>Topic</i>
Ergonomics	708	2415	1280	9826	1408	6758
Economics	1819	8356	169	3798	12340	59842
Keywords	The number of journal papers including both keywords in topics					
Ergo.&Eco.	7		307		30	

Table 2 shows eleven selected articles. According to reviewed articles and their scopes, 3 out of 11 articles considered the indirect effects of ergonomics interventions on economic benefits, and 8 out of 11 papers confirmed the cost-benefit ergonomic programs by showing the related economic data and reasoning. All of the reviewed papers were related to industrial ergonomics; however, one of them mentioned productivity and cost-benefits of ergonomics in terms of products' purchasing by customers.

Balmatee et al. (2010)

In this study, economic effects of the long-term interventional ergonomics program (1995-2007) at a major university were assessed. This research was done based on the documentation evaluation of injuries compensations, CTD incident rate, office-related recordable injuries, reported lost time, and severity of these injuries. This study confirmed the effectiveness of an ergonomic program as decreasing of CTD about 53%; thus, costs of related musculoskeletal problems also have decreased. This study shows considerable cost benefits of ergonomics and the decreasing the rate of total days by 41% confirmed the mentioned benefits, too [19].

Cuenca et al. (2010)

This interventional study done based on macro-ergonomics aimed to introduce a new practical self-assessment tool for workplace evaluation. In this research, a PVC foam factory, and also manufacturing and commercialization of balloons consisted of work cooperation bodies. The results showed that the recommended tool visualized the factory conditions; therefore, based on the diagnosis and recommendations, the characteristics and conditions of workplaces might be modified by related interventions. As a matter of fact, the authors believe that the introduced tool will highlight some important information about production processes, plans layout production, data related to the environment, evaluation of simulated emergencies, and data about the activities. Authors emphasized that, by gathering the above-mentioned information, employers will be able to develop an appropriate plan towards working conditions improvement, comfort, and health of workers in which better productivity and competitiveness will be gained [20].

Driessen et al. (2012)

This interventional study aimed to prevent low back pain (LBP) and neck pain (NP) and their unfavorable consequences among the workers at a company in the Netherlands. During the first three months of study, the ergonomic changes were done throughout an ergonomic participatory program among the intervention group. After 12 months, 34% of expected interventions were implemented, and cost-benefit calculation was done. Despite the costs of intervention in the case group, higher total health care, and productivity loss in the intervention group compared to control one, these differences were not statistically significant. Furthermore, there was no significant difference between two groups regarding working performance and sick leave. The Cost-effectiveness and cost-benefit analysis between groups showed that the entire situation in terms of costs in the control group was better than the intervention group. In fact, the intervention costs were more than the related outcomes, meaning that interventions were not cost-beneficial. The authors of this study believe that the unexpected results may be related to research limitations. Indeed, in this study, about 34% of workers in both groups did not fill out the Dutch Musculoskeletal Questionnaire (DMQ) after 6 and 12 months; moreover, only one-third of ergonomic measures were implemented in intervention departments. Authors also addressed some familiar previous studies in which all of them confirmed the succeeded ergonomic participatory measures in terms of decreasing costs. Thus, limitations of this study, insufficient filled out questionnaires, and incomplete actions resulted in the mentioned dilemma [21].

Tompa et al. (2012)

This study as an interventional study was done by a participatory ergonomics program at a clothing manufacturing company Canadian (Ontario). The costs of intervention programs and benefits were \$65,787 and intervention benefits \$360,614 (2011 Canadian dollars), respectively. In fact, the benefits were estimated 5 times more than program implementation costs. This participatory ergonomic program took 100 weeks; then, the related costs and benefits were calculated after a 44-week interval. The results showed that participatory ergonomic interventions made effective and cost-beneficial outcomes [22].

Neubert, et.al (2012)

This paper was conducted to present a model and showed the cost-benefit of industrial ergonomic changes in the workplaces at a car manufacturing company. In this research, the ergonomic workplace design (EWD) as a method of assessment was used. This study showed that the application of this method had some benefits in terms of Productivity Value (PV), occupational health, and ergonomics values [23].

Pereira da Silva(2012)

This study was done with respect to two factories of bottle production and paper converter at a glass manufacturing company. The data gathering about productivity, quality, safety-health and human resources was done by interview and questionnaire. The results showed that the managers had no a clear view about economic benefits of ergonomics. The authors believe that this sort of view might be related to the lack of documentation about work conditions. Besides, limited budget by HSE department is known as one of the reasons for this dilemma [24].

Vieira et al. (2012)

In this study done at a car manufacturing company, ergonomics as a multidisciplinary science is a core of research to show its relationship with lean production. This study shows that Kaizen strategy and planning in the working system will lead to more productivity. The authors stated that Kaizen achieved productivity as it concerned both employers and employees. The relationship between ergonomics interventions and productivity trends was asked among 10 managers who were working on production lines, HR department, Quality Control unit, Logistics unit, Performance, and communications department. The managers' viewpoints in different departments were not the same; therefore, they confirmed the ergonomics effectiveness. For instance, the Logistics department authorities considered the role of ergonomics in the improvement of productivity and work quality, indirectly. The managers of the production lines emphasized the importance of competitiveness and performance at car manufacturing companies. They also considered direct negative impact of absenteeism on productivity. The performance managers pointed to the necessity of ergonomics interventions for achieving the working related quality of life [6].

Hall-Andersen et.al. (2016)

This inductive study aimed to assess the effectiveness of ergonomics in the business. In this research, 23 volunteers participated who were working at OHS consultancies (2006-7). Five themes as the research categorized were studied as follows: "resource constraints", "maximizing project revenue", "payment for ergonomic services", "the value of ergonomic services", "the role of the client", and "coping and forming strategies to overcome resource constraints". This study also shows minor incompatibility between the opinion of engineering consultancy authorities and the role of ergonomics application, especially in terms of cost benefits aspects; however, engineering designers confirmed the critical role of ergonomics in the design process in terms of project quality. The interviewed ergonomic experts who participated in interviews were unwilling to analyze the cost benefits of ergonomic consideration as they believed that ergonomics could make a better condition for productivity; however, they could not confirm it by valid data; hence, they needed to learn how to deal with this challenge [25].

Dixon et.al (2017)

The approach of this inductive and qualitative research is a bit different from the above papers. This study aimed to explore the role of health working condition (HWC) in manufacturing companies on customers' purchases. In fact, the process of product and service design offered by manufacturers was considered. The data were gathered through face-to-face qualitative interviewing among 21 university students (9 Male, 12 Female). This study showed that participants considered HWC as a factor, and some of them stated that healthy condition at industry encouraged them to buy goods, even to pay 17.5% more than normal price; however, they are concerned about the lack of believable information about HWC and related producers' claims. This study shows that healthy working conditions at factories and ergo-branded products are known as some factors which produce effective economic outcome for producers to have a better market. Ethical goods and services are also valuable for end users; however, this is a fact that companies' authorities should win the customers' trust by intruding reliable and valid information about their working conditions [26].

Armstrong et.al (2017)

This is a 6-year cohort study paramedic service that aimed to show the effectiveness of ergonomics throughout the cost evaluations. The Hamilton Paramedic Service (HPS) and the Niagara Emergency Medical Service (NEMS) were the sources of the data, which included documents injury data and associated costs based on occupational claim management. In this study, a powered stretcher and load system intervention were considered, and the Washington State Ergonomics Costs Benefit calculator was used for the related justifications. This study shows that the implementation of power stretcher and load systems reduced MSD and the related costs by about 78 %. However, preparing the power stretcher and load systems can incur cost; the authors showed that the mentioned costs would be recovered during a seven-year period [27].

Toupin et al. (2017)

In this field study, 38 brush cutters were followed during their work in the forest (1200 m² area) to assess their conditions in terms of ergonomics. Motion study and physical workload were assessed by heart rate monitoring. In addition, the model of the IBEP (Incentive, Behavior, Effort, and Productivity) was used for assessing the workers' behavior and the related productivity. To develop a prediction model for physical workload was the main goal of this research. This study showed a relationship between effective time and independent variables of the model. In addition, the usage of introducing model confirmed more productivity (10%, increasing rate of vegetation) [28].

4. Discussion

Literature indicates that a health promotion program cannot be separated from another individual and societal goal, as communities are complex and have several interconnected factors [29]. Furthermore, health and safety are known as prominent factors in sustainable development [30, 31] in which ergonomics plays a critical role. In this regard, the main aim of this study was to map out approach which should be followed to make an appropriate association between ergonomics as a factor in sustainable development and economics as another aspect of sustainability. In this review, not only industrial ergonomics was considered, but also ergonomic product design was selected as the other sides of this review; however, both of the mentioned

aspects have a firm connection with sustainability concepts. Undoubtedly, applying ergonomics to system design is related to workers' performance and the related productivity elements [32,33, 34], and the production of ergonomic goods is also associated with industrial economic.

Unfortunately, the role of the health workforce and ergonomics design with regard to both employees' efficiency and business growth is often neglected [14], and this study was conducted to show the economic appearances of ergonomics toward the sustainability. Surely, ergonomists employment at the design process of some large-scale and well-known companies, such as Ford, Philips, Nokia, etc., confirmed directly or indirectly effectiveness of ergonomics place; however, this study was done to show other valid documents where ergonomics intervention is one of the practical and scientific ways towards more productivity and sustainability. Ergonomics consists of some different factors and approaches, i.e., healthy working conditions, job satisfaction, products' qualification, end users satisfaction, and fitting the tasks to the men [35,36,37]; therefore, this multidisciplinary science should be related to economics. This relationship is also associated with both of production conditions within factories and customers' requirements as end users of goods in the market. Several types of research show the mentioned effectiveness of ergonomics.

As mentioned, ergonomics is related to economy as all of the reviewed papers have confirmed the effectiveness of ergonomics interventions, directly (8 out of 11) and indirectly (3 out of 11). However, some dilemmas and challenges in three articles show the indirect economic outcomes. Except for one of the articles, which showed the economic role of ergonomics in the design issue, the majority of reviewed papers showed the role of industrial ergonomics.

According to reviewed papers and the authors' results and conclusions, the role of ergonomics in green economics toward sustainability is inevitable. However, there are some challenges to persuading the industrial sectors' managers of the economics side of ergonomics. According to reviewed articles and their scopes, 3 out of 11 articles mentioned about the indirect effects of ergonomics interventions; however, the authors did not satisfy available appropriate procedures to show the economic effectiveness of ergonomics. In addition, two out of these three articles have a micro-ergonomics approach and the other

focused on aspects of macro-ergonomics. Eight out of 11 articles showed the direct effect of ergonomics interventions in terms of economic aspects, in which three of them had a micro-ergonomics approach and 5 articles focused on macro-ergonomics. Figure 3 shows these eleven articles and their place in terms of economic efficiency.

Three articles show the negative effects in terms of the economic aspects of ergonomics interventions. However, the authors believe that these negative outcomes are related to limited documents about ergonomic product design and its economic aspects.

Furthermore, as Figure 3 shows, it appears that macro-ergonomics makes a better circumstance than micro-ergonomics in terms of economic aspects of ergonomics interventions. It might be related to some different aspects; for instance, micro-ergonomic design is more or less costly in advance and their outcome such as decreasing of MSDs rates needs a long-term period; however, macro-ergonomics approach more or less is based on participatory ergonomics [38] and manager's involvement and has a wide scope of organizational system.

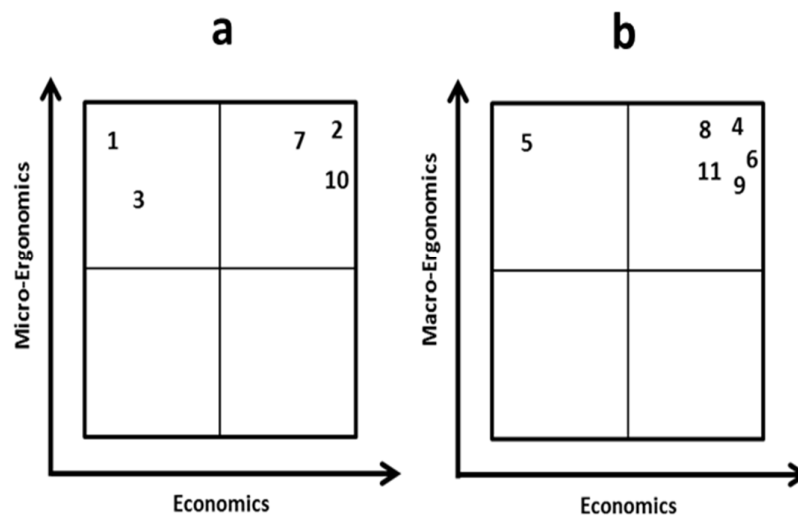


Fig. 3. The articles and outcomes in terms of cost-benefits aspects, (a) articles with micro-ergonomics approach in which No 1 & 3 did not have economics effectiveness, and No. 2, 7 & 10 had economic based benefits; (b) articles with macro-ergonomics approach in which No 5 did not have economic effectiveness, and No. 4,6,8,9 & 11 had economic benefits.

The Numbers are based on Appendix 1

5. Conclusion

This review emphasized at least two methods to show the economic effectiveness of ergonomics. One of them is the necessity of publishing papers, including valid economics model about industrial ergonomics. In this regard, making an appropriate communication between ergonomist and economics experts is necessary. Another is the lack of documents about the economic benefits of ergonomic products design. Therefore, communication between occupational ergonomics experts, product designers, and economics authorities within the industrial sectors should be considered. Besides, the researchers should fill the gaps of studies about customers' attitudes about the critical role of

ergonomic product and occupational ergonomics. Undoubtedly, both sides of industrial ergonomics and ergonomic product design are some effective ways to promote quality of life for all. The authors may recommend a model to achieve the above-referred goals through Figure (4).

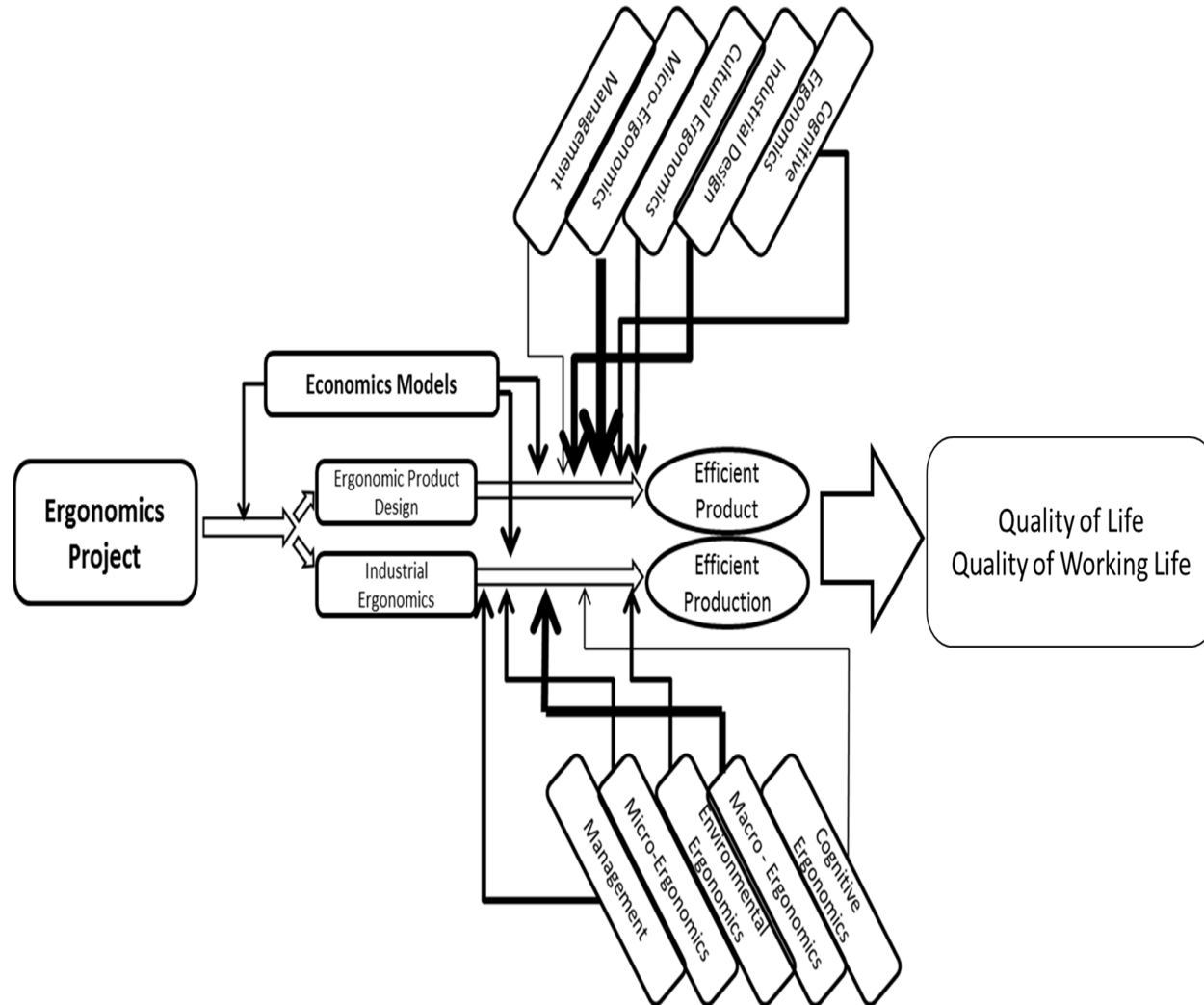


Fig. 4. Integration between economic and ergonomics interventions

Appendix. 1. Reviewed articles and authors' methodology and results

Author(s)	Location/date	Title	Methods	Results	Conclusion	Search Eng(Journal)
Driesse et al.	The Netherlands 2012	The economic evaluation of a Participatory Ergonomics (PE) programme to prevent low back(LBP) and neck pain(NP)	In this study, the Cost-effectiveness analyses (CEA) and cost-benefit analyses (CBA) were done on the health care costs including 37 randomly departments among four sectors in Germany (a steel Co., a railway transportation, an airline company, a university medical hospital). In this study, the effectiveness of Stay@Work Participatory Ergonomics programme (PE) was compared to a control group (no PE).	This study showed that the CEA of Participatory Ergonomics was not cost-effective compared to control for Low back pain and(LBP) also neck pain (NP) prevalence, work performance, and sick leave	The PE program was not effective in terms of costs; however, the authors believed that the research limitations, such as insufficient filled out questionnaires and uncompleted actions, resulted in the mentioned dilemma.	EBSCO (Work J.)
Tompa, et al.	Canada 2013	Economic evaluation of a participatory ergonomics intervention in a textile plant	This study was done in two parts. Firstly assessment of participatory ergonomics intervention on productivity at a clothing plant in Ontario in which the regression model was used. The process of intervention took 2 years which followed by a one-year post-intervention. The 2 nd parts of this research included an economic assessment about the ergonomics intervention outcomes.	This study shows a significant difference in productivity, decreasing of fingers & neck tiring, and physical exertion, based on interventions. Regression modeling results show the first aids cost reduction, as well.	Considering the reported results, it appears that participatory ergonomics interventions make effective and cost-beneficial outcomes.	EBSCO (App. Erg.J)
Hall-Andersen, et al.	Denmark 2016	Integrating ergonomics knowledge into business-driven design projects: The shaping of resource constraints in engineering	In this case, the study done was focused on three occupational health and safety (OHS) consultancies (2006-7), the ergonomic knowledge, and related services among the samples. The main aim of this study is to figure out how ergonomics can be integrated into design tasks and related business. In this natural experiment, the data gathering was done by experiment, interviews, observation and	This research showed that there is a dilemma between ergonomics interventions and cost benefits aspects; also, this study pointed out that the addition of ergonomics considerations into this business-driven design	According to the results, it seems that there is a mismatch between ergonomics application and engineering consultancy authorities. Also, there is not an appropriate consensus between engineering design experts and ergonomists in terms	EBSCO (Work J.)

		consultancy	document studies. The gathered data were analyzed throughout an inductive approach	context was constrained by an aspect of resources	of cost benefits aspects. However, engineering designers believe the necessity of ergonomics involvement in the design process in terms of project quality.	
Gabriel a Cuenca et al.	Brazil 2010	Ergonomic analysis jobs in recovered factories	In this field study, some factories were selected to evaluate ergonomic interventions. In this research, macroergonomics was focused, and data were gathered by observations and interviews among workers. To develop a self-assessment tool for working conditions survey was the main goal, as well.	The results showed that the introduced Self-Managed Work Cooperatives (Factories Recovered) a method as a software tool makes an appropriate way to collect ergonomic data.	This study shows that identification of workstations problems in terms of ergonomics and implementation of related interventions will result in the productivity.	EBSC O (Work J.)
Pereira da Silva	Brazil 2012	Is there enough information to calculate the financial benefits of ergonomics projects?	This study was done in two parts in which the first part included a systematic review, and the 2 nd one was a case study at a glass manufacturing company(including two factories of bottle production, and paper converter in which data gathering was done by factory interviews and checklists. In this study, the managers who were in charge of the following departments filled out the checklists (productivity-quality-safety&health-and human resources department)	The results showed: Lack of documentation about rules and work conditions; no belief of a relationship between ergonomics and financial benefits among managers, lack of facilities and appropriate budget in health & safety department	According to the objective of this study which was to identify if there is enough information available to properly assess and quantify the benefits expected from investments in ergonomic projects, and considering interviews which show good enough quantitative data. It appears that by making a proper management of current data, some parts of ergonomics problems might be solved	EBSC O (Work J.)
Vieira. L. et al.	Brazil 2012	Ergonomics and Kaizen as strategies for competitiveness: a theoretical and	This case study was done in an automotive industry in Brazil (Paraná), in which lean production system based on Toyota production system is used. In this research, the relationship between ergonomics and lean production system in terms of cost-benefit	This study shows that some of the workers believe that mass production is different from lean production. Some of the logistics	Based on the results, from the viewpoint of the Manufacture staffs, competitiveness and performance in automotive industries are critical; so,	EBSC O (Work J.)

		practical in an automotive industry	aspects was studied. The used methodology was also Kaizen. An interview with the workers, and also the assessment of documented data at the company was done as the data gathering methods.	supervisors mentioned that ergonomics plays a role in the elimination of workplace safety problems. Human Resources staff mentioned that ergonomics makes a better condition not only in work quality of life, but also in productivity.	ergonomics should be considered as its effects on working absenteeism decreasing.	
B.Bidasie a	U SA 2010	Limited economic evaluation to assess the effectiveness of a university-wide office ergonomics program	In this retrospective & interventional study, the economic effectiveness of long-term interventional ergonomics program at a major university was assessed. This research was done based on the documentations' evaluation of injuries compensations, office-related recordable injuries, reported lost time, and severity of these injuries.	This study showed that the ergonomic interventions made 53% and 63% decreasing rates in CTD and incident rate, respectively. Furthermore, total days away rate decreased by 41%. The rate of CTD also was halved.	Based on the gathered data in this cost-justification analysis of a university-wide office ergonomics program, this study shows that in spite of some limitations on ergonomics based data registration, implementation of an appropriate ergonomic documentation program is feasible. Authors recommend that for doing any ergonomic intervention study, a list of associated costs and benefits should be prepared as a baseline. This study confirms the effectiveness of ergonomics program benefits in terms of economics scope.	EBSC O (App. Erg.J)
Sh.M. Dixon	C ana da 2017	Young consumers' considerations of healthy	This Inductive and qualitative study aimed to explore the role of health working condition (HWC) in manufacturing companies on customers' purchases. The main data gathering method was face-to-	This study showed that participants considered HWC as a factor, and some of them stated that healthy	According to interviews, it seems that the health and safety conditions at industries are important for young	EBSC O (Ergonomics)

			face qualitative interviewing among 21(9 M,12 F) university students (average age:26).The main approach in this study based on to find out the relationship between HWC considerations at factories and customers' opinion to buy their goods or not.	conditions at industry encouraged them to buy goods even to pay 17.5% more on a \$100 product. However, they concerned about lack of believable information about HWC. Also, someone mentioned may be some of the workers faced with some unsafe condition but this knowledge rarely effects on customers during their buying the goods.	consumers, but this matter does not have effect on their purchases in the real, and it backs to the doubt about the real condition of factories. It shows that if they know that the HWC is really good at the company, they encourage buying its goods.	
D.P. Armstrong	C	Implementin g powered stretcher and load systems was a cost	In this cohort study, paramedic service was focused in terms of cost-effective intervention throughout powered stretcher. Hamilton Paramedic Service (HPS) and the Niagara Emergency Medical Service (NEMS) were the sources of six-year period data, which included documents injury data and associated costs based on occupational claim management. This research also aimed to explore the economic feasibility of a powered stretcher and load system intervention, in which the Washington State Ergonomics Costs Benefit calculator was used. The documented data and one-year intervention post data were compared.	This study shows the implementation of powered stretcher and load systems in reduced MSD and the related costs. This rate reduction was about 78% in NEMS per 100 full-time equivalents (FTE). This intervention also increased the rate modestly in HPS(24.6 per 100 FTE). This study shows that the cost of purchase powered stretcher and load systems would be recovered in 7-year considering with compensation costs reduction.	This intervention has a positive effect on MSDs decreasing in NEMS; however, the proportion of lost time (LT) incidents per MSD in the post-period relative to the pre-intervention rate had no decline. In addition, as the cost of powered stretcher and load systems would be recovered during seven years, it seems that this program makes cost-benefit conditions. Also, cost reduction of MSDs in both samples confirmed the effectiveness of this ergonomic intervention	PubMe d (App. Ergo)
D.Toup	C	Measuring the	In this case study, assessment of ergonomics	This study shows that	This study showed that	WebSc

0	in	anad a200 7	productivity and physical workload of brushcutters within the context of a production-based pay system	on physical workload and motion study among 38 brushcutter (among Sixteen silviculture companies) during their work in the forest was done. To study workers behavior, the related productivity and HR, the model of IBEP (Incentive, Behaviour, Effort,Productivity) was used. The main objective of this study was to develop a prediction model in which physical workload & work duration based on working condition during vegetal competition. In this study, worker in duration of activities was observed. Every sample should do the job in a 1200 m2 area. HR also monitored in every five-second	a relationship between effective time and independent variables of the model. This study also shows that 10% increasing rate in vegetation cover involves 2.7 h increasing as the effective time to treat a hectare, and it is also 2 h for an increase of	payment system based on piece rate might encourage the workers to do their duties and ignore the safety and ergonomics obligations. The workers get their payment as a fixed rate per hectare whether it involves hard or easy tasks; so, this kind of payment makes some ergonomic problems.	i. (Forest policy &Eco.)
1	N.Neub erta	G erma ny 2012	The charge of ergonomics – A model according to the influence of ergonomic workplace design for economical and efficient indicators of the automotive industry	This study which was done at an automotive assembly shop aimed to show that the interventional ergonomics makes some benefits and cost savings aligned with ergonomics. This paper was conducted to present a model and show that ergonomics interventions costs are not really costs; however, results will result on some economic benefits.	100 obstacles per ha In this study which initially emphasized ergonomic workplace design (EWD) as an approach to make a healthy working condition, a model was developed. This model covered the indicators which are related to economy & ergonomics. This study showed that the application of this method has some benefits in terms of Productivity Value (PV),Health Value (HV),and Ergonomic Value (EV)	The authors of this paper showed that ergonomics considerations at work make some effective outcomes. Ergonomic design at workstations effect on some indicators which are related to whole company economics. These indicators might be categorized into three levels of production, workforces and business.	WebSc i (Work J.).

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