

THE ECONOMICS OF HEALTH AND SAFETY AT WORK: A CRITICAL REVIEW

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Abstract The economic aspect of health and safety at work is increasingly gaining attention as a key factor influencing relevant policy, both in social and corporate level. Currently, this research is focused on the estimation of the large social costs of occupational accidents and diseases, as well as to the economic evaluation of interventions for health and safety at work, aiming to awareness raising of decision makers in government and enterprise level respectively. Several issues concerning the accuracy of these estimates, as well as their usefulness as a tool, rather than as a reference, in decision making are presented and discussed. Alternatively, the research on externalization of costs and inequalities is proposed as a direction of research that could offer more for decision making on Occupational Health and Safety policy.

Keywords Economics of Health and Safety; cost of occupational accidents and diseases; occupational accidents and the Economy.

1. INTRODUCTION

The economic aspect of Occupational Health and Safety (OHS) is a popular topic of scientific and "grey" literature. The economic implications of health-related risks at work are always of interest in academic and public debate. Relevant research can be found since the early 20th century.

Emphasis on the topic has increased lately, as OHS evolves from a technical/medical to a more strategic/managerial approach, engulfing elements from social sciences, such as Psychology (human error, risk perception, safety culture), Economics, etc. A series of studies from the European Agency for Safety and Health at Work (EU-OSHA) and the International Labor Organization (ILO) aim to gather and update knowledge in various aspects of the topic, while the number of countries that systematically estimate the costs of their workplace accidents and diseases is increasing.

The aim of these studies, as well as of the relevant research, is to influence policy making in OHS. However, apart from presenting large cost estimates as an "eye-opener" for enterprises or governments, influencing decision making requires certain tools and techniques that will support or oppose certain alternatives on the basis of these calculations (e.g. certain policies that will be adopted or rejected if the cost estimates are say 10% higher or lower respectively), which is further than the argument that "when new policies to promote workers' protection are developed, their economic costs are usually considered, at least implicitly" [1].

The aim of this paper, is to outline and critically discuss the state of the existing research in the topic and its contribution to policy making and understanding OHS, as well as to propose suggestions to improve this contribution.

Following the general distinction of Economics into macro and micro, research in the topic is usually divided in two directions:

- Estimation of the overall cost of occupational accidents and diseases at the social level.
- Economic evaluation of OHS interventions at the enterprise level.

Another relevant topic of research that can significantly contribute to the discussion will be examined here as a third direction: The impact of the economic cycle on occupational accidents.

The state of research in each one of these three directions will be shortly presented and discussed separately, whereas suggestions for further research and contribution to policy making will be presented together.

2. MAIN DIRECTIONS OF RESEARCH

2.1. Estimation of the overall cost of OHS at the social level

The interest for the study of the cost of occupational accidents and diseases at the social (national) level started in 1970's [2]. Ever since, a number of studies attempted to estimate these "socio-economic" costs.

Andreoni [3] reviewed 10 similar studies before 1980 estimating cost between 0.87-3.25 of GDP, whereas Beatson and Coleman [4] identified 9 studies of the 1990s estimating costs between 1.2-10.1% of GDP. Leigh et al. [5] estimated these costs to around 3% of GDP (his update for 2007 estimated them up to 1.8% of GDP - [6]).

EU-OSHA [7] quotes cost estimates from 12 EU countries that range between 0.4% (Ireland, Portugal) to 4% (Sweden). Studies for other countries estimated the costs for New Zealand for 2005 at about 3.4% [8] and for Singapore at around 3.2% [9] of GDP.

In their periodical reports, Safework Australia [10] estimates costs between 4.1 and 5.9 percent of GDP), whereas the Health and Safety Executive (HSE) [11] estimates the financial impact of workplace injuries and illnesses to around 0.8 % of the GDP in UK, excluding cancers. Similarly, the ILO estimates that 4 % of global GDP is "siphoned off" by work-related accidents and illnesses [12].

Although there is a general consensus that comparison, generalization or extrapolation of the results of different studies to other countries involves significant risks, there is a convergence of the final estimates around the one proposed by ILO. Although this convergence has made these values an almost undeniable standard in research and public debate, they still represent a very large "astronomically high figure" [13], given that occupational accidents and diseases represent 5-7% of fatalities in industrial countries and even less in developing ones [14, 15], or else 2.7% of all world Disability Adjusted Life Years (DALYs) [16]. This value would still be high even if the whole GDP was related to DALYs.

IETI Transactions on Ergonomics and Safety

<http://ietl.net/TES/>

2018, Volume 2, Issue 1, 5-16, DOI: 10.6722/TES.201808_2(1).0002

Some conclusions can be drawn by the analysis of the cost estimates of these studies (where available). The greatest part concerns intangible costs (e.g. pain and suffering) that are sometimes taken into account (HSE) and sometimes not (e.g. Safework). These costs may vary due to different methods for measurement. The remainder is dominated by lost wages that account for more than 75% of the tangible cost (either taken account as lost productivity or human capital).

The dominance of the wage-related cost element makes results very sensitive to alternative approaches for taking it into account. Literature is divided between supporters of the human capital method and the friction cost method. According to the former, the cost of absence from work equals to the respective wages that represent the foregone productivity. According to the latter, the tasks will be undertaken by another worker and the real cost is the differential (overtime or hiring and training costs). In other words, the victim and an unemployed person will just switch places in employment and social benefits.

Given the dominant share of wage-related cost to the total, the choice of the one or the other method defines the order of magnitude of the final estimate. The friction cost method obtains estimates that could be as low as 20% [17] of those obtained using the human capital method.

The human capital method would be ideal for an economy of zero unemployment. However, the existence of unemployment is still not an assurance that an injured worker will be replaced by an unemployed person [18]. Although no work-post is left vacant in the long term, the situation is different for jobs requiring particular skills. The proportion of these jobs in the economy and whether these jobs involve higher or lower exposure to occupational risks is an important criterion for choosing one method or the other or a mix of them and an interesting subject for future research.

The vast majority of the relevant studies follows the incident-based approach (estimation of all future costs of incidents occurring within one year) rather than the prevalence-based approach (estimation of costs occurring within one year for all previous incidents), as the latter suffers from a severe backload of costs [19]. Nevertheless, a parallel estimation with prevalence-based approach could be useful in cross-checking the order of magnitude of estimates, as future projections can involve several uncertainties.

The cost for the society is estimated as the sum of the costs for the government, the enterprises and the workers. Although some of these studies have efficiently dealt with double counting (which might still be present in minor costs), adding costs from different perspectives still involves important risks. Factors like economies of scale or expertise can differentiate the cost of the same element (e.g. if medical costs are undertaken by the victim or the national health system).

One cost that is referred to in literature [20] but not taken into account in relevant social cost estimates is the cost of out-of-work activities. After their shift workers also have significant duties, such as care of children or elderly parents (especially disabled ones), voluntary work, etc. A disabled worker should assign these duties to an external service. Surprisingly, this unbearable cost will rather add than reduce GDP, as this service will then involve an economic transaction.

This example underlines an important shortcoming of these studies: a static perception of the economy [21], which ignores fundamental principles of Economics, such as that total expenditure (either in prevention or treatment of health impairment) does not equal societal economic costs. In other words, it "cannot be interpreted as a loss of GDP because health expenditure forms part of GDP" [22].

Therefore, the expression that a percentage of GDP is "lost" or "siphoned off" would be more accurately described as "the costs that various stakeholders bear are equal to this percentage of GDP". Similarly, the expression "cost of poor OHS" would be better described as "costs related to occupational accidents and diseases", since the former implies that:

- by a "non-poor OHS", people would somehow become invulnerable for eight hours daily,
- if costs are higher for a developed country (which usually is the case) then its state of OHS is poorer.

2.2. Economic evaluation of OHS interventions at enterprise level

Another direction of research of the economic aspect of OHS is in the micro level, where the economic feasibility of OHS interventions is examined through case study research. The focus is on the enterprise, where certain OHS interventions are applied and evaluated.

An advantage of this direction of research is the availability and accuracy of data, compared to the studies of Paragraph 2.1 that use national aggregated data. Researchers can analyze in depth various economic aspects of an intervention and their impact on the final result.

The most documented of these studies use Randomized Control Trials (RCT) to assess the health impact of the interventions, before it is translated into economic values. These studies have been systematically reviewed in the works of Tompa et al. [23] and Verbeek et al. [24]. Moreover, qualitative studies also exist in literature (e.g. [25, 26]).

However, there are challenges for these studies too. An important one is the extent to which economic benefits of the intervention can be considered as OHS-related [24]. The economic impact of the intervention may come to a greater or lesser extent through improvement in OHS, as it can also come from other operation-related aspects affected by the intervention.

The choice of time horizon is also an important challenge. This is usually dealt with short term evaluation (e.g. using pay-back period instead of Net Present Value), which, however, means that long-term implications are not taken into account. This practically excludes OHS interventions on diseases with greater latency period. Therefore, it does not come as a surprise that most of the interventions in literature are about musculoskeletal disorders (MSD) or accidents.

Publication bias is another common drawback in such studies [23, 24]. The vast majority of the published cases show "profitable" interventions, which also explains why most of interventions in literature aim to certain ("profitable") OHS issues. However, and besides some oversimplified statements in "grey" literature, OHS interventions cannot always be beneficial, as such a phenomenon would violate fundamental economic principles [27].

On one hand, an intervention can either be successful or not in terms of OHS improvement [28, 29, 30, 31]. On the other hand, like all other interventions, it can either be economically profitable or not, regardless of its OHS-related impact.

The main factors that affect the profitability of an OHS intervention are the type of intervention (organizational, technical, etc.), the scope and type of OHS issue (overall OHS, MSDs, accidents, skin disorders, etc.), the size of investment (capital employed), workers' participation and the method of measurement and assessment [26].

The main weakness of these studies is that generalizations to other interventions (or even to a different context for the same intervention) are problematic. Even well structured (RCT) studies are limited to a narrow spectrum of parameters as it is hard to replicate all the factors affecting an intervention. This fact reduces the use of such studies for policy making.

2.3. The impact of the economic cycle on occupational accidents

An older but less developed direction of research examines the reverse relation between Economics and OHS, i.e. the impact of the economic cycle on occupational accidents. It includes econometric analyses with economic indices (GDP, unemployment rate, etc.) as an independent variable and occupational accidents (total or fatal) as the dependent variable. A relevant literature review can be found in [32].

This research started with the work of Kossoris [33], who found that (reported) accidents at work increase when employment was also increasing in the manufacturing sector in the US. He attributed this relation to four factors:

- Decreasing job tenure (inexperienced workers) in economic upturns.
- Increasing work intensity in upturns.
- Vintage capital (e.g. old unsafe machinery) employed in upturns.
- Increasing under-reporting in downturns.

On the contrary, Nichols [34], emphasized on the vulnerability of workers in economic downturns, which reduces their bargaining power to demand better working conditions and consequently increases risks. Since labor is a scarce resource in economic upturns:

- the number of occupational accidents should decrease as costs of absenteeism or replacement increase [35]
- workers are in better situation to claim and obtain better working conditions [34].

The pro-cyclical patterns found in previous works were attributed to a lag between economic downturns and unemployment.

This controversy partly reflects the dispute over which parameters of the economic cycle actually affect accident rates. A part of the relevant literature focused on unemployment [36, 37, 38, 32, 39] or employment rates [40, 41], GDP per capita [42, 43, 44, 45, 46] or a set of indices [47]. Many of these studies examine data for fatal accidents as a more reliable proxy, since they are not as susceptible to underreporting [48, 37].

This dispute (over solid numerical patterns) also reflects that this direction of research is much less developed than the other two, mainly due to its insufficient theoretical background. The most important problem of this research is the need for long time data series that are difficult to obtain and that also are affected by changes in work environment, sectoral structure, technology and medical evolution (e.g. a fatal accident of the 60s may not be fatal nowadays).

Another silent assumption of this research is that accidents are exclusively defined by the economic cycle, which leads to ambiguous conclusions. Factors like improvement in regulation, management techniques, technological evolution of equipment, etc. have a consistent effect on accidents regardless of the economic cycle, which can be represented by a linear or other monotonic curve. The effect of the economic cycle should then be assessed as a deviation from the expected curve, rather than as a standalone value. This assessment should be conducted separately for every sector of the economy, to avoid the effect of the changes in sectoral structure of the economy over time.

The development of this direction of research, which examines the relation between OHS and the Economy from the reverse point of view, could help in better understanding of this relation as well as to provide better projections for planning and policy making. Nevertheless, this effect can only be limited, since this research focuses only on accidents (or even more, fatal accidents) without taking long latency period diseases into account.

3. SUGGESTIONS FOR RESEASCH

3.1. Impact on policy making

There is general consensus in literature that market mechanisms do not suffice to ensure optimal OHS for workers and thus government intervention for improvement of OHS is necessary to provide motives [49, 50, 51]. Since work is an economic activity, all issues related to this (i.e. OHS) cannot be efficiently dealt with unless their economic aspect is systematically examined [26].

According to the EU-OSHA/ILO study [52] the main role of OSH Economics in policy making is:

- a) awareness raising
- b) understanding the distribution among stakeholders
- c) comparing the costs of action and inaction
- d) identifying priorities (e.g. sectors)

e) identifying the linkages between OSH and other policy interventions.

Most emphasis has been given to the first point (a). Measuring the social costs of poor OHS is expected to raise awareness for governments to take action for OHS regulation and initiatives, as well as showing that "safety pays" is expected to raise awareness for enterprises.

The usefulness of such Cost of Illness studies in general with regards to policy making has already been criticized [53]. Beside these deficiencies, after four decades of presenting very high estimates of this cost, this argument must have exhausted its influence potential.

The distribution of costs among stakeholders (b) has been discussed in all relevant literature and it is present in all studies estimating total social cost. However, its major issue for policy making, the externalization of costs from enterprises to workers and governments, has not been particularly researched. This issue is further discussed in Paragraph 3.2.

To assist decision making, an economic study should present the cost of both alternatives (c). The reduction of accidents and diseases and of their cost, will come as a result of efforts that will have an implementation cost. The difference between these costs is the net cost, which defines the economic motive. Studies that would estimate the "cost of OHS" along with the "cost of non-OHS", are required to document decision making. Such cost can be found in enterprise-level studies (Paragraph 2.2) or some certain case studies (e.g. [54]) but not in the social level (Paragraph 2.1).

The necessity to focus separately on different sectors (d) has also been emphasized in earlier studies [55]. However, despite some sector-focused studies (mainly by Leigh) there has not been sufficient relevant research, at least to the extent that would allow for cross-sector comparisons. Nevertheless, such a distinction is necessary as OHS (and its cost) issues are quite different between different sectors and the aggregation could confound the true picture.

The last point (e) emphasizes the need for integrating OHS into a general policy. Such a step would require economic evidence and conclusions on certain as well as general OHS policy issues that would advise or guide the decision makers. However, this is not the case, even in the most developed countries. The same study [52] concludes that "To be honest, policy integration has played only a very minor role in OSH programming in the industrialized countries."

3.2. Proposed directions for research

In this paper, it is claimed that focus should rather be set on cost externalities that can provide certain economic motives to complement OHS regulation. The most common form of externalization has to do with costs transferred from enterprises to the victim or to the government, due to the non-existence of an OHS insurance scheme, or due to fixed insurance premium that is not depended on safety performance (experience rating) or due to increased under-reporting of accidents, which varies between different countries [56, 57], economic situations [33], types of incidents [58] or sectors [59]. Cost shifting can also take place from an enterprise to the other. Such examples are sub-contracting of activities (and risks) or vacancy chains (i.e. when a vacancy caused by an illness or accident is filled by employed job-seekers of other enterprises).

IETI Transactions on Ergonomics and Safety

<http://ietl.net/TES/>

2018, Volume 2, Issue 1, 5-16, DOI: 10.6722/TES.201808_2(1).0002

In a wider view, externalities should be seen in a wider view of risk dumping, including transfer of risks from one enterprise to another (sub-contracting) or from one country to another. Although it is expected that enterprises in countries with lower working standards should be more competitive as they bear lower costs to obtain these conditions, these countries show up low in the ranking of competition [60].

This could be partly attributed to the fact that they simply externalize their OHS costs, that are shifted to the society in higher levels (due to lack of economies of scale and expertise) as costs of accidents and diseases that will deteriorate the overall competitiveness of the economy.

Proper policy making should lead to interventions that are feasible, fair and favor healthy competitiveness. Such policies require a proper mix of regulation and economic motives, on the basis of who bears the costs and/or enjoys the benefits. Research could help shedding light on these issues by revealing the magnitude and distribution of all costs. Such an effort could change the priorities of each existing direction of research:

1. Definition of the "net" relationship between unemployment or output and the workplace accidents, with proper econometric models that will exclude the impact of other factors. This could be achieved with different studies per sector taking into account an enduring linear reduction trend that represents advances in technology and regulation.
2. Targeted enterprise-level pilot studies aiming to reveal the magnitude and distribution of costs (either directly OHS-related or not) and benefits for certain examined or planned interventions at the national level.
3. COI studies for certain OHS issues and certain sectors, identifying the costs for each stakeholder, with parallel studies for the costs of the intervention and their distribution to stakeholders.

By providing this input to policy making, certain feasible OHS policies can be planned, implemented and evaluated and appropriately amended depending on changes in external factors, such as unemployment or growth in certain sectors or the Economy as a whole.

4. CONCLUSION

The economic evaluation in health issues aims to assist decision making by identifying and analyzing [61]:

- a) The order of magnitude of costs.
- b) Different alternatives.
- c) Different perspectives.

Currently, research in OHS Economics is focused on revealing the overwhelming social costs of occupational accidents and diseases at the social level (a) and the profitability of OHS interventions in

enterprise level, aiming to act as an "eye-opener". A number of uncertainties regarding the estimation of social costs has been presented. Moreover, the appropriateness of using estimates as a percentage of GDP has been critically discussed.

Decision making requires estimates of the net cost of action or inaction of alternatives (b), which would require studies for the cost of reducing accidents and diseases, not only at the enterprise level, but also at the social level.

In this paper, it is claimed that governments and enterprises are efficient in identifying huge costs or sources of economic benefits; even if there were not, the multitude of such studies for the last four decades would have convinced them.

Therefore, it is proposed that the focus of relevant research be on investigating and leveraging economic motives (either at the social or at the enterprise level) in order to set the proper incentives, and to understand the mechanisms that could make it necessary to revise them as economic and social conditions change. The aim is to improve the distribution of costs to the stakeholders (c) in order to minimize the inequalities and loss of competitiveness due to externalization of costs of accidents and diseases.

References

- [1] EU-OSHA - European Agency for Safety and Health at Work, 2014, *Estimating the cost of accidents and ill-health at work: A review of methodologies*, Luxembourg: Publications Office of the European Union, <https://osha.europa.eu/en/publications/reports/estimating-the-costs-of-accidents-and-ill-health-at-work/view>
- [2] Lees P.F., 1996, *Loss prevention in the process industries*, 2nd Edition, Reed Educational and Professional Publishing, Oxford.
- [3] Andreoni D., 1986, *The Cost of Occupational Accidents and Diseases, Occupational Safety and Health Diseases*, International Labour Office, Geneva.
- [4] Beatson M. and Coleman M., 1997, International Comparisons of the Economic Costs of Work Accidents and Work-Related Ill-Health 1997. In Mossink, J., and Licher, F., (eds.) *Costs and Benefits of Occupational Safety and Health: Proceedings of the European Conference on Costs and Benefits of Occupational Safety and Health 1997*, The Hague, 28-30 May.
- [5] Leigh J.P., Markowitz S., Fahs M., Shin C., and Landrigan P., 1996, *Costs of Occupational Injuries and Illnesses, NIOSH Report U60/CCU902886*, NIOSH, Atlanta, GA..
- [6] Leigh J., 2011, Economic Burden of Occupational Injury and Illness in the United States, *The Milbank Quarterly*, 89(4): pp.728–772.
- [7] EU-OSHA - European Agency for Safety and Health at Work, 1999, Economic Impact of Occupational Safety and Health in the Member States of the European Union, <https://osha.europa.eu/en/tools-and-publications/publications/reports/302>
- [8] Pezzulo L., and Crook A., 2006, The Economic and Social Costs of Occupational Disease and Injury in New Zealand. NOHSAC Technical Report 4, www.worksafe.govt.nz/worksafe/about/publications/nohsac-reports/technical-report-04.pdf/view.
- [9] Loke Y.Y., Tan W.J., Manickam K., Heng P., Tjong C., Lim G.K., Lim S., Gan S.L., and Takkala J., 2013, Economic Cost of Work-related Injuries and Ill-health in Singapore, *Singapore Workplace Safety and*

IETI Transactions on Ergonomics and Safety

<http://ietl.net/TES/>

2018, Volume 2, Issue 1, 5-16, DOI: 10.6722/TES.201808_2(1).0002

Health Institute,

www.wsh-institute.sg/files/wshi/upload/cms/file/Economic%20Cost%20of%20Work-related%20Injuries%20and%20Ill-health%20in%20Singapore.pdf

- [10] Safework Australia, 2012–13, The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community, www.safeworkaustralia.gov.au/system/files/documents/1702/cost-of-work-related-injury-and-disease-2012-13.docx.pdf
- [11] HSE - Health and Safety Executive, 2011. Cost to Britain of workplace injuries and work related ill health: 2010/11, www.hse.gov.uk/statistics/pdf/cost-to-britain.pdf?pdf=cost-to-britain
- [12] ILO - International Labour Organisation, 2009, World Day for Safety and Health at Work: Facts on safety and health at work, April 2009, www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/documents/publication/wcms_105146.pdf
- [13] Lebeau M., and Duguay P., 2013, The Costs of Occupational Injuries. A Review of the Literature. IRSST Special Project, <http://www.irsst.qc.ca/media/documents/pubirsst/r-787.pdf>
- [14] ILO- International Labor Organization, 2006, Occupational Safety and Health: Synergies Between Security and Productivity, Geneva, http://www.ilo.org/wcmsp5/groups/public/@ed_protect/@protrav/@safework/documents/meetingdocument/wcms_110380.pdf
- [15] Murray C, and Lopez A., 1996, Global Burden of Disease. Geneva: World Health Organization (WHO)/World Bank/Harvard School of Public Health, http://apps.who.int/iris/bitstream/10665/41864/1/0965546608_eng.pdf
- [16] Leigh J., Macaskill P., Kuosma E., and Mandryk J., 1999, Global Burden of Disease and Injury Due to Occupational Factors, *Epidemiology*, 10(5): pp.626-631
- [17] van Beeck E.F., van Rooijen L., and Mackenbach J.P., 1997, Medical costs and economic production losses due to injuries in the Netherlands, *Journal of Trauma*, 42(6): pp.1116–1123.
- [18] Johanneson M., and Karlsson G., 1997, The friction cost method: a comment, *Journal of Health Economics*, 16: pp.249-255
- [19] Targoutzidis A., Koukoulaki T., Pinotsi, D., Skiadas C., and Pappa M., 2011, Original Sins of Insurance systems: The case of the Greek Occupational Risk Insurance Scheme, IKA-ETAM, *International Journal of Contemporary Economics and Administrative Sciences*, 1(2): pp. 90-102
- [20] Targoutzidis A., Chatziioannou C., Tsaklis P., Karakoltsidis P., Vayiokas N., Bezirtzoglou E., Stefanou K., Ioannidis S., Lazar V., Chifiriuc C., Altintas N., Demir C., Karababa A.O., Groen H., Welling G., Harmsen H., Degener J., Stoilova D., Dimitrov P., Nikolov C., Ganchev G., Strintzis M. and Fotiadou E., 2011, Repository of Occupational Well-being Economics Research, ROWER project, www.rower-eu.eu
- [21] Dorman P., 2000, The Economics of Safety, Health and Well-Being at Work: An Overview, InFocus Program on SafeWork, International Labour Organisation, www.ilo.org/safework/info/publications/WCMS_110382/lang--en/index.htm
- [22] WHO - World Health Organization, 2009, WHO guide to identifying the economic consequences of disease and injury, WHO Library Cataloguing-in-Publication Data, www.who.int/choice/publications/d_economic_impact_guide.pdf?ua=1
- [23] Tompa E., Dolinschi R., de Oliveira C., and Irvin E., 2007, A systematic review of OHS interventions with economic evaluations, Institute for Work and Health, www.iwh.on.ca/sys-reviews/a-systematic-review-of-ohs-interventions-with-economic-evaluations
- [24] Verbeek J., Pulliainen M., and Kankaanpää E., 2009, A systematic review of occupational safety and health business cases, *Scandinavian Journal of Work Environment and Health*, 35(6): pp.403-413
- [25] Antonelli A., Baker M., McMahon A., and Wright M., 2006, Six SME case studies that demonstrate the business benefit of effective management of occupational health and safety, Research Report 504, prepared by Greenstreet Berman Ltd for the Health and Safety Executive, <http://www.hse.gov.uk/research/rrpdf/rr504.pdf>

IETI Transactions on Ergonomics and Safety

<http://ietl.net/TES/>

2018, Volume 2, Issue 1, 5-16, DOI: 10.6722/TES.201808_2(1).0002

- [26] EU-OSHA - European Agency for Safety and Health at Work, 2014, The business case for safety and health at work: Cost-benefit analyses of interventions in small and medium-sized enterprises. Luxembourg: Publications Office of the European Union, <https://osha.europa.eu/en/tools-and-publications/publications/reports/the-business-case-for-safety-and-health-cost-benefit-analyses-of-interventions-in-small-and-medium-sized-enterprises>
- [27] Tompa E., Dolinschi R., and Laing A., 2009, An Economic Evaluation of a Participatory Ergonomics Process in an Auto Parts Manufacturer, *Journal of Safety Research*, 40: pp.41-47.
- [28] Miller P., Whynes D., and Reid A., 2000, An economic evaluation of occupational health. *Occupational Medicine*, 50(3), pp. 159-163.
- [29] Miller P., Rossiter P., and Nuttall D., 2002, Demonstrating the economic value of occupational health services, *Occupational Medicine*, 52(8), pp. 477-483.
- [30] Mossink J.C.M., and Nelson D.I., 2002, Understanding and Performing Economic Assessments at the Company Level, Protecting Workers' Health No 2, Geneva, World Health Organisation, <http://www.who.int/bookorders/anglais/detart1.jsp?sesslan=1&codlan=1&codcol=85&codcch=3814>.
- [31] Owen K., 1996, Economic cost of poor performance in occupational health and safety. *Journal of Occupational Health and Safety Australia and New Zealand*, 12(5), pp. 609-617.
- [32] Terrés de Ercilla F., Mondelo P.R., Casado A.E., and Vilella E.C., 2004, Economic fluctuations affecting occupational safety. The Spanish case, *Occupational Ergonomics*, 4: pp.211-228.
- [33] Kossoris M.D., 1938, Industrial injuries and the business cycle, *Monthly Labor Review*, 66(5), pp. 579-595
- [34] Nichols T., 1986, Industrial injuries in British manufacturing in the 1980's – a Commentary on Wright's Article, *Sociological Review*, 34(2), pp. 290-306.
- [35] Steele G., 1974, Industrial Accidents: An Economic Interpretation, *Applied Economics*, 6(3): pp. 143-155.
- [36] Eshler J.M., 1977, Filtering of Fatal-Accident Rates, Transportation Research Record, Issue Number 643, Transportation Research Board of the National Academies.
- [37] Boone J., and van Ours J.C., 2006, Cyclical Fluctuations in Workplace Accidents. Institute for the Study of Labor (IZA). Discussion Paper No. 627, <http://econpapers.repec.org/paper/cprceprdp/3655.htm>
- [38] Santana V.S., and Loomis D., 2004, Informal Jobs and Non-fatal Occupational Injuries, *Annals of Occupational Hygiene*, 48(2): pp. 147-157.
- [39] Ostry A., 1998, Historical Trends in the Epidemiology of Injury and Industrial Disease at the B.C. Worker's Compensation Board (1950 – 1996), A Report Prepared for the B.C. Royal Commission on the Worker's Compensation Board, <http://www.qp.gov.bc.ca/rcwc/research/ostry-injury.pdf>
- [40] Adams J.G.U., 1985, *Risk and Freedom*, Transport Publishing Projects, Cardiff.
- [41] Partyka S.C., 1984, Simple Models of Fatality Trends Using Employment and Population Data, *Accident Analysis and Prevention*, 16: pp. 211–222.
- [42] Biddle E., 2004, Cost of Fatal Occupational Injuries in the United States, 1980-97, *Contemporary Economic Policy*, July: pp. 370-381.
- [43] Davies R., and Jones P., 2005, Trends and Context to Rates of Workplace Injury, Research Report 386, Warwick Institute for Employment Research, University of Warwick, <http://www.hse.gov.uk/research/rrpdf/rr386.pdf>
- [44] Davies R., and Jones P., 2000, An Analysis of Temporal and National Variations in Reported Workplace Injury Rates, Institute for employment and research, The University of Warwick, <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.137.8342&rep=rep1&type=pdf>
- [45] Beatson M., 1995, *Labor Market Flexibility, Employment Department Research Series*, The Employment Department., 48, London
- [46] Barth A., Winker R., Ponocny-Seliger E., and Sögner L., 2007, Economic growth and the incidence of occupational injuries in Austria, *Wiener Klinische Wochenschrift*, 119(5-6), pp.158-163.
- [47] Mouza A.M., and Targoutzidis A., 2012, The impact of the economic cycle on fatal injuries. The case of UK 1971–2007, *Quality and Quantity*, 46(6), pp. 1917–1929.

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2018, Volume 2, Issue 1, 5-16, DOI: 10.6722/TES.201808_2(1).0002

- [48] Saloniemi A., and Oksanen H., 1998, Accidents and fatal accidents – some paradoxes, *Safety Science*, 29: pp. 59-66
- [49] Bailey S., Jørgensen K., Koch C., Krüger W., and Litske H., 1995, An Innovative Economic Incentive Model for Improvement of the Working Environment in Europe, Luxembourg, Office for Official Publications of the European Communities, <http://www.eurofound.europa.eu/pubdocs/1995/18/en/1/ef9518en.pdf>
- [50] OECD - Organisation for Economic and Co-operation and Development, 1989, Occupational Accidents in OECD Countries, <http://www.oecd.org/dataoecd/63/54/3888265.pdf>.
- [51] Culyer A.J., Amick III B.J., and Laporte A., 2008. What is a little more health and safety worth? In: Tompa E., Culyer C.J., Dolinski, R. (Eds), *Economic evaluation of interventions for occupational health and safety (1st ed)*, Oxford University Press, Oxford (NY).
- [52] Dorman P., 2012, Estimating the Economic Costs of Occupational Injuries and Illnesses in Developing Countries: Essential Information for Decision-Makers, Working Paper, Programme on Safety and Health at Work and the Environment (SafeWork), International Labour Office, http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/publication/wcms_207690.pdf
- [53] Tarricone A., 2006, Cost-of-illness analysis: What room in health economics, *Health Policy*, 77(1): pp. 51–63
- [54] Law Commission of Ontario, Best Practices from Outside Ontario, <http://www.lco-cdo.org/en/our-current-projects/vulnerable-workers-and-precarious-work/commissioned-papers/new-approaches-to-enforcement-and-compliance-with-labour-regulatory-standards-the-case-of-ontario-canada/v-best-practices-from-outside-ontario/>
- [55] Leigh J.P., McCurdy A., and Schenker M.B., 2001, Costs of Occupational injuries in Agriculture, *Public Health Reports*, 116(3), pp. 235-248
- [56] Feyer A.M., Williamson A., Stout N., Driscoll T., Usher H., and Langley J., 2001, Comparison of work related fatal injuries in the United States, Australia and New Zealand: method and overall findings, *Injury Prevention*, 7, pp. 22-28.
- [57] Spangenberg A., Baarts C., Dyreborg J., Jensen L., Kines P., and Mikkelsen K.L., 2003, Factors Contributing to the Differences in Work Related Injury Rates Between Danish and Swedish Construction Workers, *Safety Science*, 41, pp. 517-530
- [58] Van Doorslaer E., and Bouter L., 1990, Assessing the economic burden of injuries due to accidents: methodological problems illustrated with some examples from the literature, *Health Policy*, 14, pp. 253-265
- [59] Hämäläinen P., Takala J., and Saarela K.L., 2006, Global Estimates of Occupational Accidents, *Safety Science*, 44, pp. 137-156.
- [60] Takala J., Hämäläinen P., Saarela K.L., Yun L.Y., Manickam K., Jin T.W., Heng P., Tjong C., Kheng L.G., Lim S., and Lin G.S., 2014, Global estimates of the burden of injury and illness at work in 2012, *Journal of Occupational and Environmental Hygiene*, 11(5), pp.326-337
- [61] Drummond M.F., O'Brien B.J., Stoddart G.L., and Torrance G.W., 2005, *Methods for the Economic Evaluation of Health Care Programmes*, Oxford University Press, Oxford.