

CALCULATION OF THE ECONOMIC EFFECTS OF WORKING ENVIRONMENT AT COMPANIES AND ORGANISATIONS – A SURVEY OF EXISTING METHODS

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Methods to assess economic effects related to the work environment at companies and organizations are summarized and evaluated. Information was found in the open literature and by discussions with developers, researchers and end-users. The results show that several methods exist and an overview is presented here. Effects of uncertainties in the input data and the underlying assumptions are discussed. It is concluded that the application of the methods available would be stimulated by improved guidelines and by making a collection of case studies available in the public domain. Recommendations for future methodology development work are also given.

Key-words: work environment, economic assessment, methods, survey

1 Introduction

Poor working conditions lead to negative effects for individuals, companies and for the society. It is well known that a poor work environment (WE) affects the health of the employees in a negative way. In addition, the WE at a company may influence its business results [20]. Methods to relate WE to the business results have been developed and are used when analyzing investments affecting the WE [11], [16]. However, the awareness of such methods is generally poor, as well as the knowledge about how to use them. Further, several of the models available do not link the WE and business results at such level of detail that they provide results adequate for decision making.

2 Objective

The objective of this study was to summarize information about existing methods to assess the economic effects related to WE at companies and organizations and to evaluate them with respect to certain criteria. Another aim was to outline development needs in this field.

3 Methods

Information about available methods was mainly sought in the databases Ergonomics Abstracts and Medline within the field of WE and economic models, focusing on publications from the last decade. Documentation from some recent international conferences and work-shops in the field were studied specifically. Information was also searched via the authors' professional networks to find models not described in the open literature.

Of the methods found a selection for further evaluation was made by the authors after discussions with representatives for users and researchers in the field. Important criteria for the selection were if the methodology is clearly documented and to what extent it is applied. To clarify essential details the methods' developers or owners were contacted.

For some of the methods also end-users were contacted to obtain feed-back on user-perspective issues.

4 Results

Without being complete the study has shown that there exist a number of methods suitable for analysis of the economics effects of the WE. These methods are aimed at meeting different needs and are therefore suitable for different tasks. To evaluate the methods, certain criteria were established by the authors in collaboration with the mandator The National Institute of Working Life in Sweden, see the left column of Tables 1-3. A selection of ten different methods was evaluated according to these criteria.

The methods selected can be categorized into three groups: *A*) methods for analysis of WE risks *as well as* calculation of their economic impact, *B*) methods for development and evaluation of suggestions for intervening measures in combination with investment analysis and *C*) methods focusing on investment analysis in connection to WE investments. The results are summarized in Tables 1-3. A more detailed description is available (Rose & Orrenius, 2007).

Table 1: Evaluation of the Swedish Social Insurance Agency (Försäkringskassans) program for calculation of costs at sick-leave and the Health Account.

Category	N/A	N/A
Criterion	F-kassans model [4] & [21]	Health Account [5], [11] & [19]
1. At what organisations & issues/questions is it applicable?	All kinds of organizations. Sick-leave costs are calculated.	All kinds of organizations. Accounting linked to health and personnel, WE and absence.
2. What kind of work/intervention can be analyzed?	All.	The method aims at presenting health and WE on company level but is less suited for evaluating interventions at work stations etc.
3. Which methodology is used?	Cost analysis for sick-leave. Fixed mark-up for assessment of over-head cost.	The format is not fully defined but can be adapted to the organization being analysed.
4. Are productivity effects considered?	No.	Possible, see above.
5. Are quality deficiency effects considered?	No.	Possible, see above.
6. What input data are needed and in which format?	Wages and absence based on company data or assessments.	Sick-leave data must be available. The format is not fully defined but can be adapted to the organization being analysed.
7. How are results presented (which parameters)?	Costs due to absence per hour or per sick-leave period.	Depending on format ,see above.
8. What resources are needed (input data, analysis, etc)?	A few hours/ analysis.	Depending on format ,see above.
9. How is it documented (quality, availability, language)?	Manual in Swedish (internet).	Books and articles in Swedish and Finnish.
10. Who are intended users and what competence is needed?	Company management & Staff department.	WE staff, economy, HR and business managers.
11. Is it available as computer program? (price, support, language)?	Yes as freeware, without support. Only in Swedish.	No.

Table 2: Evaluation of Tool Kit, SCA&MAWRIC, WEST and ROHSEI

Category	A	A	A	B
Criterion	The Tool Kit [1]	SCA & MAWRIC [18]	WEST [8]	ROHSEI [11]
1. At what organisations & issues/questions is it applicable?	Developed for textile industry. Applicable to all kinds of organizations & WE problems.	All kinds of organizations & WE problems except psychosocial ones.	Developed for the manufacturing industry. Applicable to all kinds of org. & WE problems.	Developed for large companies. Applicable to all kinds of organizations.
2. What kind of work/intervention can be analyzed?	All.	All.	All.	All.
3. What methodology is used?	Investment calc., checklists, risk assessment, economic analysis.	Risk analysis, risk management & Cost Benefit (C/B)-analysis for measures.	Risk assessment for six WE factors. Calc. of cost/worked hour WEST-points).	Problem identification, develop solutions, analysis (investment calc. etc), documentation and recommendations.
4. Are productivity effects considered?	No.	Yes, as a fixed mark-up & assessment of productivity loss due to reduced capacity.	Yes, only for psychosocial factors. Not for those due to physical WE.	Yes, possible to define productivity as "hidden impact".
5. Are quality deficiency effects considered?	No.	Yes, as part of a fixed mark-up.	No.	Yes. Possible to define quality as "hidden impact".
6. What input data are needed and in which format?	In-house data about WE factors, e.g. epidemiologic data. C/B data.	In-house data, trade statistics about work injuries. C/B data. Productivity deficiency in %.	Risk assessments for six different WE factors. Data about working hours.	C/B data. Data for recruitment costs, intervention etc., productivity & quality deficiencies. Employee data.
7. How are results presented (which parameters)?	Risk analysis, C/B for investments.	Personal injury risks, action suggestions, costs and their relation to profit & turn-over.	Costs for six different WE factors in kSEK/million work hours.	Financial key figures, ROI, & discounted pay-back time, etc.
8. What resources are needed (input data, analysis, etc)?	Approximately one day per analysed department.	Risk analysis is time consuming. Calculation of results takes a few hours.	About 50 hours for a company with 60 employees.	1-2 days for inexperienced users.
9. How is it documented (quality, availability, language)?	Detailed article in English. Information at homepage in Spanish.	PhD thesis & conference paper in English, technical reports in Swedish.	Workbook & short description of methodology in Swedish.	Overview article in English (without details and case studies).
10. Who are intended users and what competence is needed?	Multi-disciplinary working teams at companies.	Company and production managers, WE staff, researchers etc. Competence in injury risks needed.	Those working with WE issues & LCA. Competence in ergonomics needed. Training required.	WE staff, anyone who want to assess an investment in WE. Knowledge of method required.
11. Is it available as computer program? (price, support, language)?	Yes, English, Spanish & Korean. Free for in-house use. Licence for consulting work.	No.	No.	Yes, English. Price: USD 500.

Table 3: Evaluation of Balloon-model, Net-Cost Model, Potential and ProductAbility Tool.

Category	B	C	C	C
Criterion	The Balloon model [6]	The Net-cost model [9] & [10]	The Potential [13]	The ProductAbility Tool [15] & [16]
1. At what organizations & issues/questions is it applicable?	All kinds of organizations & WE problems.	All kinds of organizations & WE problems.	All kinds of organizations & WE problems.	All kinds of organizations & WE problems.
2. What kind of work/intervention can be analyzed?	All.	All.	All.	All.
3. Which methodology is used??	ROI analysis. Method structured in eight steps from problem description to follow-up.	ROI analysis. Questionnaire for data collection, e.g. physical symptoms & productivity.	ROI analysis. C/B analysis made for ten different areas.	ROI analysis. focusing at productivity loss related to WE deficiencies.
4. Are productivity effects considered?	Yes.	Yes.	Yes.	Yes.
5. Are quality deficiency effects considered?	Possible.	No.	Yes.	No.
6. What input data are needed and in which format?	C/B data, productivity- & quality deficiency in monetary terms	C/B data, injury frequencies, productivity in % (time and efficiency loss).	C/B data, productivity & quality deficiency etc. in monetary terms.	Employee data, C/B data, in monetary terms, productivity loss in %.
7. How are results presented (parameters)?	C/B, pay-back time.	Net cost for investment & pay-back time.	Costs before and after intervention and total ROI.	C/B, pay-back time & reports.
8. What resources are needed (input data, analysis, etc)?	Depending on character of analysis. Starting at a few hours.	1-2 days.	About 1 day for an experienced user.	About 1 day for an experienced user.
9. How is it documented (quality, availability, language)?	Well documented in books & articles in Swedish & English.	Well documented. Articles in English, case studies, questionnaires on Internet.	Article in English, software manual in Swedish & English including examples.	Well documented in books and articles in English including good discussion and case studies.
10. Who are intended users and what competence is needed?	Company and production managers, WE staff, etc. Knowledge of method needed.	Researchers, company and production managers, WE staff, etc. Economic competence needed.	Company and production managers, WE staff, etc. Economic competence needed.	Company and production managers, WE staff, etc. Economic competence needed.
11. Is it available as computer program? (price, support, language)?	No.	No.	Yes, in Swedish & English. Price: 10 000 SEK. Support available.	Yes, in English. Price: 620 AUS \$. Support available.

Contacts with Swedish end-users show that four out of ten organizations apply no routines or methods to assess the economic effects of the WE. Two of them calculate costs related to sick-leave and the remaining four organizations use methods developed by Liukkonen. The results from this and a previous study (Nilsson & Rose, 2004) indicate that methods to calculate the economic effects of the WE are used to some extent. However, it is unusual to systematically link the WE to sick-leave and even more uncommon

in the methods to include effects on business core values, such as productivity and quality. None of the end-users in the study considered the methods they presently applied to account for all relevant factors in sufficient detail.

5 Discussion

The results show that several methods suitable for analyzing the economic effects of WE exist. However, it is also observed that they are not widely spread at companies. One reason may be lack of knowledge about existing methods, or that these methods are considered to be difficult to understand or use. Another reason may be that the existing methods don't link the work environmental factors to company core values in sufficient detail, e.g. due to lack of relevant input data. Furthermore, it is sometimes argued that such methods are not needed, as the improvements necessary for a good WE are made without economic arguments. The multidisciplinary approach needed to efficiently apply the methods, involving several different departments of the organization, may also be an obstacle.

Uncertainties in the underlying assumptions of the models can be divided in three parts: One is uncertainties regarding input data in the WE analysis, especially when they have to be estimated. Another is uncertainties regarding the relations between the WE factors and factors important for the company business results, e.g. productivity. Thirdly, the relations between quality, and suchlike factors, and the company result may also lead to uncertainties. Sensitivity analysis is one way of handling uncertainties in input data (Tomba et al., 2006).

Only few models found in this survey account for "hidden costs" due to quality deficiencies. If only measurable factors are included in a model and thereby significant factors are excluded, the analysis gives an incorrect picture of the economic effects which may lead to inaccurate priorities and actions.

The need for perusing research regarding improved economic evaluation modelling was highlighted at ECON 2004 (Eijkemans & Fingerhut, 2005). A "good" method should provide a framework for structuring input data (Lahiri et al., 2005a) and also stimulate reflection when the different model input parameters are assessed (Biddle et al., 2005). Some development needs have been identified in the present work. These are e.g. *i*) improved relationships between WE conditions and factors strongly linked to the business results, e.g. productivity and quality, *ii*) inclusion of relevant hidden costs, such as psychosocial factors and motivation, *iii*) transparency in the models, i.e. the relations applied must be described, *iv*) adjustment to language that the user is familiar with and local laws, *v*) applicability of user-defined relations between WE and cost-factors and *vi*) user guidance by guidelines and detailed case studies from different types of work situations and industrial fields. More detail is given by Rose & Orrenius (2007).

6 Conclusions

A number of methods suitable for analyzing the economic effects of WE are available. A few of these are implemented in user friendly computer programs. The application of the available methods would be stimulated by more detailed application guidance, in particular for estimation of costs related to productivity and quality deficiencies and also by provision of detailed case studies from different types of work situations and industrial fields. Development needs in this area are identified. In particular regarding

improving the links applied in the models between WE and parameters essential to the business results, such as productivity and quality.

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