CHAPTER 11

The Economics of Ergonomics

THIS CHAPTER PROVIDES:

- Design concerns when addressing the well-being, performance and retention of future workforce.
- Case studies showing how ergonomics and economics are interlinked.
- Descriptions of stakeholder relations and persuasive behaviours.
- Some cost-related calculation procedures to evaluate an ergonomics investment.

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WHY DO I NEED TO KNOW THIS AS AN ENGINEER?

Quite frequently, the people in a company who know the most about human factors and ergonomics are not the people who “own” the design problem or the design of assembly solutions; that is, they do not have the right themselves to change the workplace. This is especially true for ergonomists – for many of them, it becomes absolutely essential to develop interpersonal skills and a “language of economics” so that they can use cost-related persuasive arguments when communicating with people who have the mandate to put money and resources towards making a change (for example engineers, production leaders, economists). Frequently, problem owners have many other considerations to balance alongside ergonomics.

This means that if you want to implement ergonomics improvements, it is important to be able to analyse and discuss the trade-off between short-term demands of company leadership and the long-term benefits of ergonomics – in the language of cost-benefit analyses.

There is a paradox in the “economics of ergonomics”; when you choose to invest in good ergonomics proactively, it is hard to know exactly how much unnecessary cost has been avoided. This can sometimes make it challenging to convince management who are reluctant to make ergonomics investment. On the other hand, waiting to address bad work environments and work design until the workforce has been injured can spin off into a chain of costly effects (assembly errors, quality deficiency, sick leave, rehabilitation, compensation, costs for new recruitment, training of new staff and quality/speed deficiencies while new staff are under training, etc.)

For this reason, gaining knowledge from case studies and company records is a good way to develop arguments showing how the costs of bad ergonomics can propagate. From another angle, there are many case studies showing that improved ergonomics can improve safety, productivity, efficiency and quality, which all lead to profitability. Your ability to reason in these terms can greatly leverage your success in convincing other stakeholders and implementing workplace improvements in general, not just ergonomics.

WHICH ROLES BENEFIT FROM THIS KNOWLEDGE?

Any role that takes part in discussions of whether to invest in changes to the workplace can benefit from understanding the short- and long-term mechanisms of targeting ergonomics problems to avoid costly repercussions later. Typically, not many people who partake in such a discussion at companies are necessarily educated in seeing those connections, and therefore any engineer with an understanding for the economical benefits of good ergonomics can present a sound business case that shows what risks may end up costing much more than the initial short-term calculation may show. The *manager/leader* and *purchaser* who understand the difference between short- and long-term elimination of costly ergonomic risks and inefficiencies may both still be rare, but we hope to inspire more people in positions of leadership and economic responsibility to leverage this knowledge – particularly the less obvious investments into cognitive and psychosocial improvements. The *system performance improver* and *work environment/safety specialist* obviously benefit in their business case arguments from using examples from previous successful interventions, and highlighting which short- and long-term benefits may positively impact the work, the workers and the company. The *sustainability agent* would do well to add these economic perspectives to any discussion of how to make the workplace more sustainable from a combined social and economic perspective – for any intervention that makes good business sense has a better chance of making a lasting positive impact on operations.

11.1. Proactive or reactive approaches to ergonomics investments

Despite all the evidence that the design of a workplace and its associated tasks can trigger MSDs, causing sick leave and long-term illness for employees, many companies do very little to implement ergonomics principles in their business activities. Typically, companies only adopt a *reactive* approach when investing in ergonomics – they wait until the situation has become so bad that they have to react. This means that "quick and dirty" short-term solutions are implemented when complaints arise, but these solutions may not solve the root issue or provide lasting benefits. A reactive approach doesn't stop ergonomic issues from arising; rather, it means a number of people are "sacrificed" to the poor design of the workplace before anyone commits attention or resources to changing it.

In reality, the majority of ergonomics issues result from the design of the product and its associated assembly tasks, and so are actually already established in the design and planning phases, often years before production even begins. So adopting a *proactive* approach — where ergonomic considerations are planned in years ahead by designers, decision makers and production engineers — is a far superior approach. That will not only provide safe and healthy workplaces for employees, but is also likely to facilitate increased levels of productivity. There are many interconnected factors that influence production ergonomics, the majority of which are dictated by the design of the actual product itself. Figure 11.1 (from Munck-Ulfsfält, 1997) shows how all these factors affect the conditions of the assembler.

By adopting a proactive approach, it is possible to establish an assembly method with a minimal amount of ergonomics problems. As can be seen in Figure 11.2, the level of influence on ergonomics is highest at the start of the project before any design decisions have been finalized. The costs to make changes are also lowest at the start of the project, so it is most favourable from an economic standpoint to adopt a proactive approach.

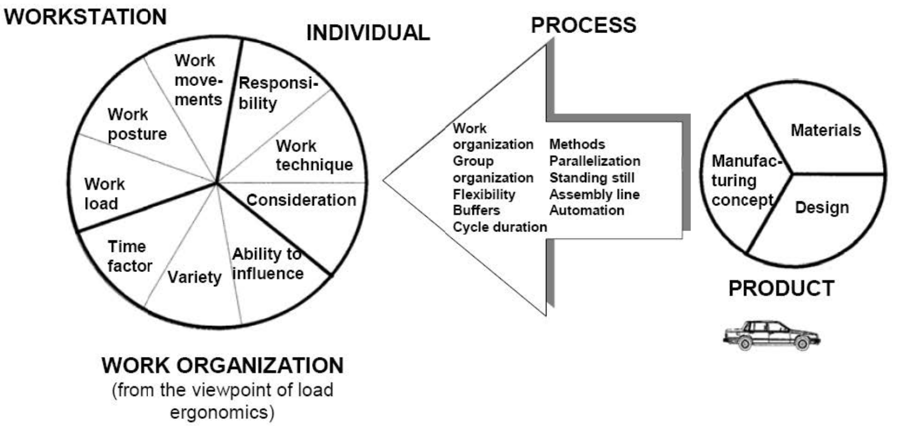


Figure 11.1: Holistic view of factors that affect production ergonomics (Munck-Ulfsfält, 1997).

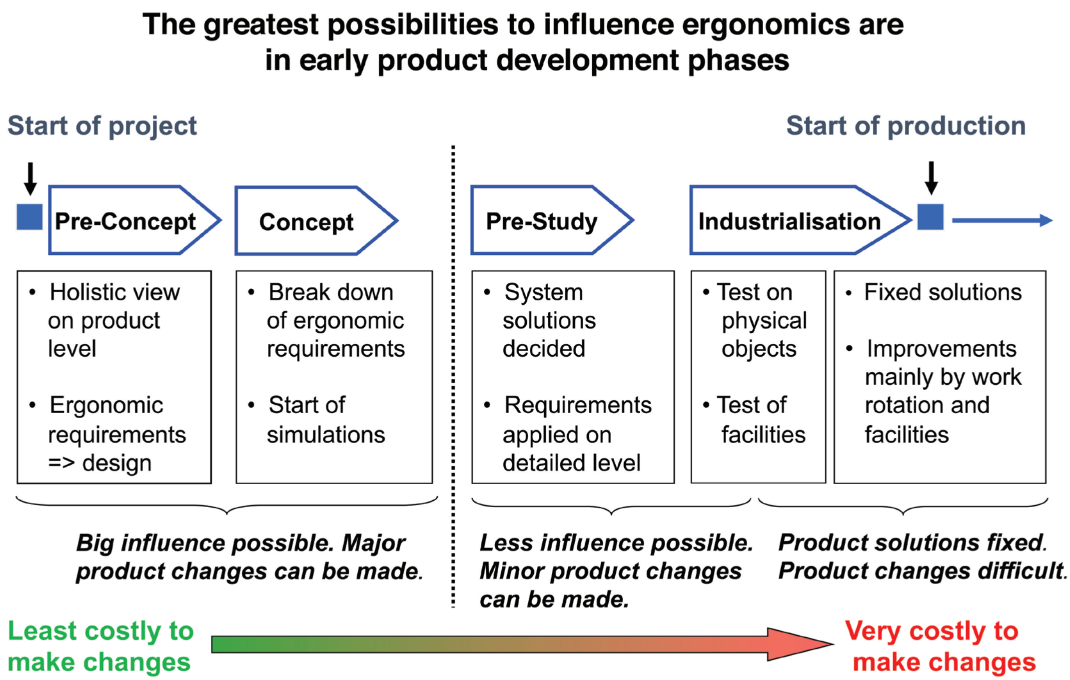


Figure 11.2: Level of influence and associated costs for good production ergonomics (Lämkull, Falck and Troedsson, 2007).

When trying to implement ergonomics changes, there is a need to speak a language of economics – something that many ergonomists and engineers often have limited experience of. If the awareness of negative consequences is low, it becomes necessary to quantify desirable changes in terms of costs. Education and training is also key – introducing engineers to ergonomics at university level is an important enabler for system improvements through ergonomics. Providing stakeholders and decision makers at all levels within the company (including workers) with training is also key in enhancing the workplace. The biggest scope for cost savings in companies comes from adopting a proactive approach to ergonomics, ensuring from the start of any project that harmful postures, high loads, poor tooling and excessive materials handling is avoided. If companies wait and take a reactive approach, injuries continue to happen and the ability to eliminate them will be limited and involve high costs. By contrast, a proactive approach enables modification to be made to the design and hazardous ergonomic conditions can be avoided.

Fundamentally, the lack of consideration of ergonomics by companies is due to economics and an uncertainty as to whether the costs associated with ergonomics really pay off in the long run. The costs associated with poor ergonomics aren't only associated with money and can be seen at three different levels:

- Costs to the individual
- Costs to the company
- Costs to society

11.2. Individual costs

From an individual perspective, there are a number of costs associated with a work environment that fails to take ergonomic considerations into account. The following list, adapted from Niu (2010 p. 748) exemplifies a few of the costs that burden individual workers:

- Pain and suffering due to injuries and occupational diseases (including Repetitive Strain Injuries (RSI), Cumulative Trauma Disorders (CTD) and repetitive motion injuries)
- Medical care costs
- Lost work time
- Lost future earning and fringe benefits
- Reduced job security and career advancement
- Lost home production and child care
- Home care costs provided by family members
- Adverse effects on family relations
- Lost sense of self-worth and identity
- Adverse effects on social and community relationships
- Adverse effects on recreational activities

Once a worker has an MSD or is experiencing pain on such a level that they can no longer carry out their job, the costs start to be counted. In many cases, workers are able to go back to work after a few days on sick leave. During prolonged periods of sick leave, however, individuals will no longer receive their full salary – rather, they are given sickness compensation, which is considerably lower. In the long term this will have significant impact on their personal economy, as their pension will also be affected.

There are also less measureable costs for the individual. While sick, opportunities for promotion and career advancements are significantly reduced; this can in turn affect the individual's job satisfaction and self-esteem. There is also a high degree of personal development and social interaction that comes with a job and losing these can have lasting psychological impacts on people. The combination of these costs in the form of lost money, time, competence and opportunities, can sometimes have a cumulative negative effect; injuries inhibiting a person's capacity to work can in some cases lead to cases of depression.

Ergonomics problems on an individual level are commonly solved (reactively) by medical staff using rehabilitation techniques. In some cases the root cause of the injury is identified, however this is not always the case, so without design changes the injury trigger could still remain a latent risk to other workers.

11.3. Company costs

A large number of costs resulting from poor ergonomics fall on the company. These costs can be categorized into the following areas:

- "Presenteeism"
- Sick leave
- Employee turnover
- Production losses
- Quality and business losses
- Legal costs

"Presenteeism"

Workers who have sustained an injury during their job can be split into two categories: those who are in pain but still manage to go to work, and those who are so injured that they can physically no longer work. Thus *presenteeism*, as opposed to absenteeism, is the state when workers ignore discomfort or pain and keep working. For workers that manage to work through the pain, costs still accrue to the company as the injured worker can no longer carry out their work to the same standard or speed, so the quality and productivity of their tasks will decrease. There may also be instances where they take a few hours off here and there to visit the hospital, meaning either the work won't be done or others will have to be paid to work overtime. Possible consequences of presenteeism include an increased risk of sudden injuries and accidents, lower product quality, slower pace of work, greater worker dissatisfaction and increased scrap rates.

Having unfit workers in the workplace can also affect morale as they start to resent their work; this can have a demotivational effect on other workers. In some cases, if possible, the production leader occasionally moves affected workers to so-called easier work tasks. However, these kinds of tasks are usually very limited, implying that this solution could not be offered to all who need it, nor for very long periods of time.

Sick leave, or absenteeism

The costs are even more significant for the company, when employees need to take prolonged periods of sick leave. Not only does the company need to continue to pay the sick individual's salary, but they may also need to pay others to work overtime, or in some cases have to hire subcontractors or recruit new personnel. When staff are fit enough to return to work, there may also be rehabilitation and retraining costs that the company will incur. There may also be less spare capacity to deal with emergencies that require extra staff.

Employee turnover

It is often said that people are the most valuable resource in a company and that their value increases with experience. However, poor work environments lead to a high turnover of personnel as people are either too injured to work or choose to leave the company as the job does not fulfil their needs and they fear that they will become sick if they stay too long. Hiring new staff to cover for absent individuals can be a costly and time-consuming process. Time, money and resources are spent advertising, interviewing, hiring and training new staff; there are also phase-out costs associated with employees who leave. It is very unlikely that new employees will work at the same rate as the sick experienced staff member they are replacing, so productivity rates are bound to slow initially. Time and attention is also taken up from other experienced workers who have to coach and support the new employee.

Production losses

Production losses frequently occur as a result of poorly designed workplaces and absenteeism. Productivity rates drop with the introduction of new employees and the increase of errors. Significant time may also be spent investigating injuries or accidents, reducing the production capacity of certain parts of the assembly line further.

Quality and business losses

A number of quality-related issues stemming from poorly designed workplaces have costs associated at a company level. A number of errors may occur when workers are in pain, fatigued, forced to adopt poor postures, unmotivated or bored. The introduction of new inexperienced employees or workers from other departments being called in to cover a shift can also lead to errors. The loss of productivity resulting from absent staff means meeting deadlines becomes harder, resulting in increased stress levels as staff rush to meet demand, which can also result in errors. At best, these errors means some components have to be scrapped or time spent to modify them, and at worst the error could go unnoticed meaning the product has to be recalled after it has already gone to market and reached the customer. Quality losses mean that scrap costs increase, as well as large sums of money being spent on recalls and warranties. There are also costs associated with the loss of the company's public image, their reputation will suffer and credibility will be lost, which will not only affect profits but can also make it harder to attract new (much-needed) employees. Such scenarios mean that focus, time and resources are spent by managers conducting accident and error investigations, rescheduling tasks and supervising workers. All of these cause reduced managerial focus as all their time is spent resolving urgent issues and keeping the company afloat, rather than planning for the long term.

Legal costs

In some cases workers press charges and take companies to court over the poor working environment they were subjected to, resulting in companies paying substantial fines as well as their corporate image being damaged. In general, a reactive culture of workplace health and safety may lead to higher insurance and compensation claim costs.

11.4. Societal costs

Bad workplace design triggering the onset of injuries also presents costs to society as a whole. According to research by Leigh (2011), medical and indirect costs of occupational injuries in the USA amount to at least the same costs as cancer, and since worker's compensation programs cover less than 25% of those costs, the economic burden befalls society. According to statistics from the International Labor Organization (ILO), work-related injury and illness costs vary between 1.8 and 6.0% of GDP in country estimates, with the average being 4%, and if involuntary early retirement is counted into the economic burden, the percentage can rise to staggering levels, such as in Finland (up to 15% of GDP!) according to Takala et al. (2014). The number of people needing medical care as a result of badly designed workplaces is also an issue for society, since so many hospital resources are taken up. For example, in 2007 the Swedish Social Insurance Agency, *Försäkringskassan,* paid over 99 billion SEK in benefits to individuals (Försäkringskassan, 2008). Using legal sanctions, this cost is often passed on onto companies, so instead of solving the root issue, the blame is just shifted.

11.5. Solving the problem

Despite the fact that the costs connected to poor ergonomics are vast and affect a number of people at different organisational levels, gaining approval from stakeholders for changes can be a challenging task. Given the multitude of different investment options across different sectors in companies, gaining approval from top-level management and sufficient funding to carry out projects can be a battle. With limited resources, companies have to prioritize needs and tend to invest in the most profitable venture. Given that those specializing in ergonomics rarely have the power to make the final decision when it comes to finance, they need to persuade investors of the economical value before they can carry out their job as an ergonomist. This can be difficult as the language of economics is very different to ergonomics or engineering. Everything needs to be discussed and quantified in terms of financial savings and benefits. Obtaining accurate figures to convey this information can be difficult as in reality, if an effective ergonomics program is implemented proactively, the costs of what could have been are never really fully known. While some of the cost benefits are obvious, such as reduced sick leave and less worker compensation pay-outs, there are also hidden costs like loss of productivity, employee turnover and quality issues.

To be fully equipped to implement ergonomic principles on a large scale in an industrial context, it is necessary to have:

- An awareness of the benefits gained by other companies.
- Tools and methods to aid in quantifying the benefits.
- Effective communication skills to convince the necessary stakeholders.
- Knowledge and the power to act and implement change.

11.6. Building awareness

The best way to raise awareness is through case studies that highlight how greater attention to ergonomics has brought about numerous benefits and cost savings in another business. The car industry is one sector that has been particularly strong in ensuring ergonomics considerations are made from the outset of projects. In 1999 a study at Ford Motor Company found that the hidden costs associated with bad ergonomics were three times worse than the more obvious costs, giving a combined total of $141 million as a result of bad ergonomics (Figure 11.3).

Figure 11.3: Direct and indirect costs of poor ergonomics that were once calculated at Ford Motor Company (adapted from Stephens, 1999).

Illustration by C. Berlin, based on Stephens (1999).

The costs associated with bad ergonomics were also noticed at Volvo Car Corporation; with estimates indicating that on average poor ergonomic work operations costs $170,000 annually (Falck, 2005). Another study at Volvo Car Corporation tracked the link between poor ergonomics and quality, in the form of errors. By following the assembly of 24,442 cars and monitoring the physical load levels of assembly tasks it was found that tasks with medium or high level would result in a 3.5 times higher risk for quality deficiencies, leading to 8.5 times higher costs to manage the associated errors (Falck, Örtengren, & Högberg, 2010). Another study at Volvo highlighted the importance of taking a proactive approach to ergonomics. With action costs for errors in the factory discovered late in assembly costing 9.2 times more than those repairs discovered at the early stages. In addition action costs to correct quality errors that were only detected once the products had reached the market were a further 12.2 times more expensive to correct compared to actions taken in the factory (Falck, Rosenqvist, 2014). Such benefits from improved ergonomics aren't limited to the car industry; research by Hendrick (1996) identified 25 cases across numerous different industries (ranging from the forestry industry to food service stands at a baseball stadium) where the implementation of ergonomics programs provided benefits.

Another effective way to increase awareness throughout a company is through ergonomics training programs. Equipping workers at all levels (including production technicians, manufacturing engineers, design engineers, production leaders and team leaders among others) with knowledge about ergonomics and how poorly designed workplaces can be improved, highlights that ergonomics is everyone's responsibility. Educating decision makers, project leaders and those with the power to make proactive production changes is urgent in prompting change. While empowering workers to take control of their workplace means that issues will be identified and reported earlier so modifications can be made before it's too late. Training also provides significant benefits at an organizational ergonomics level, as workers are more likely to take responsibility for their work and look out for colleagues, which increases morale creating a better working atmosphere.

11.7. Cost calculations

Cost calculations are the most effective way of convincing investors of the value of implementing ergonomics programs. Chances are that if an ergonomics improvement is seen as an improvement opportunity with measureable gains (Budnick, 2012) rather than just an investment cost, the more likely that the investment will be made.

Given the diverse and international nature of manufacturing industry, with bases of cost sometimes being very specific to the rules and regulations of specific countries, it is very difficult to use one standard tool for every situation or company. Numerous different attributes need to be taken into consideration when determining costs, so obtaining all the necessary data to make an accurate calculation may produce a need for very specific calculation models that are especially adapted to the country and situation in question. Nevertheless, we will try to discuss some general principles for cost calculations.

In general, demonstrating the value of improved ergonomics involves calculating the return on investment (ROI), a very basic metric that can be expressed by the following equation (often expressed as a percentage):

$$\text{ROI} = \frac{\text{Gains from investment} - \text{Costs of investment}}{\text{Costs of investment}} \times 100$$

Finding sources for ergonomics gains involves creative consideration of how a solution may positively impact the following system performance aspects (according to Budnick, 2012):

- productivity gains
- quality gains
- injury Prevention
- injury Management
- absenteeism reduction
- employee retention
- enhanced customer experience

It may be wise to focus on productivity and quality gains in particular, since most companies already measure and base a lot of decisions on those two metrics. In general, gains can be counted from two different perspectives when motivating an ergonomics investment: 1) an avoidance of losses, such as eliminating sick leave or scrap costs, or 2) increased revenue, such as increased output per time unit, higher quality, etc.

On a general level, demonstrating the value of investing in workplace ergonomics is about clearly demonstrating the balance between costs incurred by poor ergonomics, the cost of implementing a solution, and – most importantly – the economic returns that justify the investment into improving the workplace. You have to 1) determine the costs of losses and inefficiencies, 2) the costs of implementing the improvement, 3) the gains that result from the improvement, 4) the *time span* or *amount of products* that will measure the point at which the investment costs are compensated for by the improvement, i.e. the *break-even* point, and 5) the projected gains that will continue once the break-even point has been passed.

A convincing cost calculation will be very specific in detailing the costs of risks, time losses, sick leave costs, tool inefficiencies, materials scrap costs, etc. Sometimes, proposing a new solution becomes an exercise in not just motivating how the problems are going to be eliminated, but also demonstrating how many more additional gains can be achieved with a new solution. In other words, a bit of extra creativity goes a long way towards persuading the stakeholder with purchasing power. For instance, implementing a machine to do a previously dangerous or strenuous task may not just decrease sick leave costs, but also decrease the amount of time needed to make a product and the uniformity of the products, resulting in a higher output at a better level of quality, which can in turn increase sales profits.

The following case study (based on an article by Johrén, 2001) shows an example of the many factors that can contribute to improvement opportunities for ergonomics that can be presented as gains.

CASE STUDY

An electricity company was experiencing a number of ergonomics issues and was considering investing in sky lift equipment to reduce the load and injury risks on workers. To determine if the investment would pay off the following calculation was made (Johansson, Johrén, 2001).

Issues

- High absenteeism, 12 days per employee
- 20% have chronic back/joint problems
- 25% of the absence due to back problems
- Too strenuous for some female employees
- Strenuous for employees over 50 years of age
- Strenuous for employees with back/joint problems
- Risky working task, especially if the poles are rotten

Annual costs for skylifts	
Cost for one sky lift	150 000 SEK
Economic life length, 8 years	
Rest value, 10%	15 000 SEK
Interest rate, 15%	
Yearly cost	32300 SEK
Service & maintenance	7700 SEK
Sum	40 000 SEK
Annual cost for 10 sky lifts	400 000 SEK
Time gains at assembly with sky lift	
Time gain ½ h per pole	
100 poles assembled by working group & year	
Price 500 SEK/h (debiting price)	
Time gain for 1 sky lift?	
50 hours × 500 SEK/h	25 000 SEK/sky lift & year
Time gain for 10 sky lift?	
10 × 25 000 SEK	250 000 SEK/year
Time-gain per year:	**250000 SEK/year**

Reduced sick leave due to less back problems

- Today: 12 days sick leave per employee/year
- 25% regarded to be related to back problems
- Absenteeism cost estimated to 300 SEK/h
- Assume this can be reduced by 5%
  How large is the reduction in sick leave days then?

12 days × 165 × 25% × 5% = > 25 days

Reduced sick leave due to fewer back problems

How much are the costs for that absence reduced?

25 × 8 h × 300 SEK/h = > 60 000 SEK/year

Reduced sick leave cost: 60 000 SEK/year

Reduced absence due to fewer work accidents

Absence due to work accidents during the last year for employees with this task was 400 days; assume that the accidents can be reduced by 10%.

How much is this reduction in days?

Reduction: 40 days

How much are the costs for that absence reduced?

40 × 8 h × 300 SEK/h = > 96 000 SEK/year

Reduced cost due to fewer accidents: 96 000 SEK/year

Better use of the employees

Assume that people over 50 years of age and those with back and joint problems can work with a 2% productivity increase (20% of these 165 employees), with the total working hours per year = 1500.

How much is the revenue increased due to better use of the employees?

Revenue due to better use of employees: 495 000 SEK/year

(In addition: better job satisfaction, equality and customer satisfaction increase)

Total gain /revenue	
Gains from time savings at assembly	250 000 SEK/year
Reduced sick leave	60 000 SEK/year
Reduced absence due to fewer accidents	96 000 SEK/year
Better use of the employees	495 000 SEK/year
Total revenue	901 000 SEK/year
Profit	501 000 SEK/year

Sensitivity Analysis

Given that some assumptions were made in this calculation to prove that a profit would still be generated with more conservative figures a sensitivity analysis was also carried out.

- If sick leave reduction only is 2.5% (instead of 5%)
- If the accidents only are reduced by 5% (not 10%)
- If the use of employees with MSDs only increases with 1% (instead of 2%)

Costs	400 000 SEK
Revenues = 250 000 + 30 000 + 48 000 + 248 000	**576 000 SEK**

11.8. Case studies of ergonomics interventions

As part of convincing other stakeholders that an ergonomics-related design change will pay off, it may help to demonstrate examples of other cases where an intervention has been proven to have a positive economic impact. A number of case study examples have been collected in ergonomics literature to document how the removal of a health and safety risk resulted in several other gains as well, such as increased efficiency, speed, fewer accidents and wasteful mistakes, etc. Although calculation methods vary a great deal and the aspects taken into account are different, there are a number of examples of successful implementations of everything from new personnel routines to safety gear to weight handling equipment. Hal Hendrick (1996) describes several such cases in an article titled "Good Ergonomics is Good Economics", and several websites have compiled case studies to prove that by and large, Hendrick's catchphrase still rings true. The *Ergonomics Cost-Benefit Case Study Collection* provided by the Puget Sound Chapter of the Human Factors and Ergonomics Society (PSHFES, 2012; Goggins et al., 2008), and the case study collections housed on the websites of the United States Department of Labor (OSHA, 2016), the UK's Health and Safety Executive (2016) or the Canadian Centre for Occupational Health and Safety (CCOHS, 2015) all provide an array of examples of how ergonomics interventions played out in different work sectors.

11.9. Tools and calculation methods

A number of methods for ergonomics return on investment calculations exist, of which some are tools and others are calculation principles. While a number of tools do exist that relate business benefits in terms of cost to ergonomics, at present the lack of awareness and understanding coupled with the tools insufficient level of detail creates a barrier to their successful implementation.

The following sections list a variety of available cost calculation methods and tools, some of which are available online. The selection is mainly based on Rose and Orrenius (2006), but the list has been curated to include source materials in English and (mostly) publicly available tools (accessible via the provided links).

Calculate costs for sick leave absence

Some social security services may provide services for employers and employees to calculate the costs of individual sick-leave. For example, the Swedish Social Insurance Agency *Försäkringskassan* provides an online cost calculator to calculate individual costs for work absences due to ill health or injury. This calculator is adapted to Swedish social security regulations and compensation rates. The calculator is available online (Försäkringskassan, 2017).

SCA and MAWRIC

SCA(Statistically Based Cost Analysis Method) and MAWRIC (Method to Analyse Work related Risks, Improve work environment and estimate total Cost) are both developed by Rose (2001). SCA is used to gain an overview of the costs at group or company level for company- or sector-specific MSDs. MAWRIC is used to identify and assess MSD risks caused by specific tasks or occupations, and to suggest improvement.

Data required to use the methods:

- company or sector statistics of injuries and sick leave
- estimated productivity losses due to presenteeism
- risk assessments
- estimation of metrics after improvement
- data for costs and earnings

ROHSEI (Return on Health, Safety and Environmental Investments)

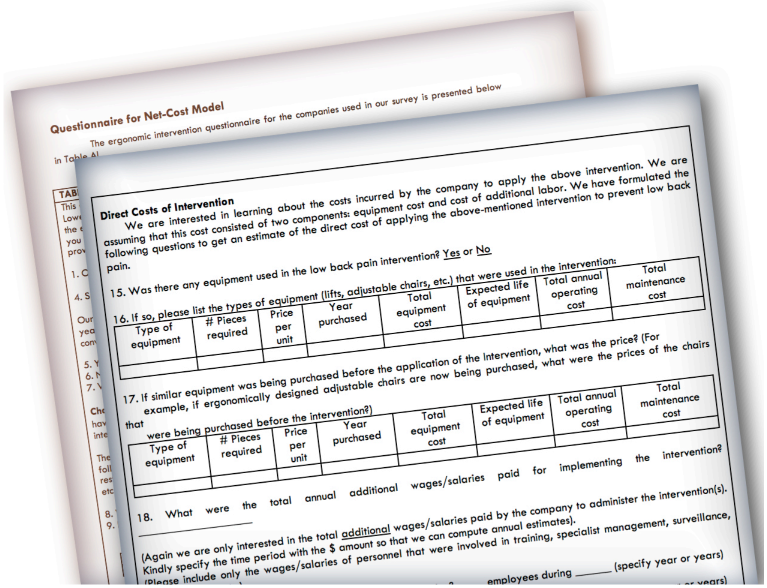
ROHSEI (Linhard, 2005) is a tool intended for team use, allowing typical financial metrics to be applied to health and safety improvements. It is described as a four-step process as follows:

- Understand the opportunity or challenge.
- Identify and explore alternative solutions.
- Gather data and conduct analysis.
- Make a recommendation.

Output metrics include net present value, return on investment, internal rate of return, and discounted payback period. (Also available as a commercial software through ORC Networks, 2011.)

Net cost model for workplace intervention

In this questionnaire-based method, described in Lahiri et al. (2005a and 2005b) and Lahiri (2005), net costs and net gains are calculated at company level for proposed ergonomics interventions targeted at decreasing the occurrence of MSDs and work disabilities (e.g. hearing loss). The net costs are calculated over a year and the method can calculate the investment's payback time. The method is available in the appendix of Lahiri et al. (2005a) or at http://faculty.uml.edu/slahiri/supriyajan28-website.doc (Lahiri, 2005).



Questionnaire for Net-Cost Model

The ergonomic intervention questionnaire for the companies used in our survey is presented below in Table A1.

Direct Costs of Intervention

We are interested in learning about the costs incurred by the company to apply the above intervention. We are assuming that this cost consisted of two components: equipment cost and cost of additional labor. We have formulated the following questions to get an estimate of the direct cost of applying the above-mentioned intervention to prevent low back pain.

15. Was there any equipment used in the low back pain intervention? Yes or No

16. If so, please list the types of equipment (lifts, adjustable chairs, etc.) that were used in the intervention:

Type of equipment	# Pieces required	Price per unit	Year purchased	Total equipment cost	Expected life of equipment	Total annual operating cost	Total maintenance cost

17. If similar equipment was being purchased before the application of the Intervention, what was the price? (For example, if ergonomically designed adjustable chairs are now being purchased, what were the prices of the chairs that were being purchased before the intervention?)

Type of equipment	# Pieces required	Price per unit	Year purchased	Total equipment cost	Expected life of equipment	Total annual operating cost	Total maintenance cost

18. What were the total annual additional wages/salaries paid for implementing the intervention? ________

(Again we are only interested in the total additional wages/salaries paid by the company to administer the intervention(s). Kindly specify the time period with the $ amount so that we can compute annual estimates).

(Please include only the wages/salaries of personnel that were involved in training, specialist management, surveillance,

employees during _____ (specify year or years)

Figure 11.4: Illustration of the Net Cost Model questionnaire.

Image by C. Berlin, based on Lahiri (2005) and Lahiri et al. (2005a, 200b, 2005c and 2005d), with support from the WHO.

The Productivity Assessment Tool

Developed by Oxenburgh and Marlow (2005), this tool (Also known as the ProductAbility Tool in its software version) is a calculation tool that considers the following aspects (adapted from Oxenburgh and Marlow, 2005 p. 211):

Data concerning employees	Number of employees, their working time and wages, overtime, and productivity
Data concerning the workplace	Supervisory costs, recruitment, insurance, and other general overheads, maintenance, waste, and energy use, as applicable
The intervention	In the test cases the costs, or estimated costs, for the intervention
The reports	Cost-benefit analysis calculations and reports of the workplace and the employees

Washington State ergonomics cost-benefit calculator

Developed by the Puget Sound Chapter of the Human Factors and Ergonomics Society (PSHFES), this calculator (PSHFES, 2012), which is based on a review of 250 cost-benefit analysis cases for ergonomics investments (Goggins et al., 2008) is available as an excel file with pre-specified fields for specifying costs for work-related MSDs.

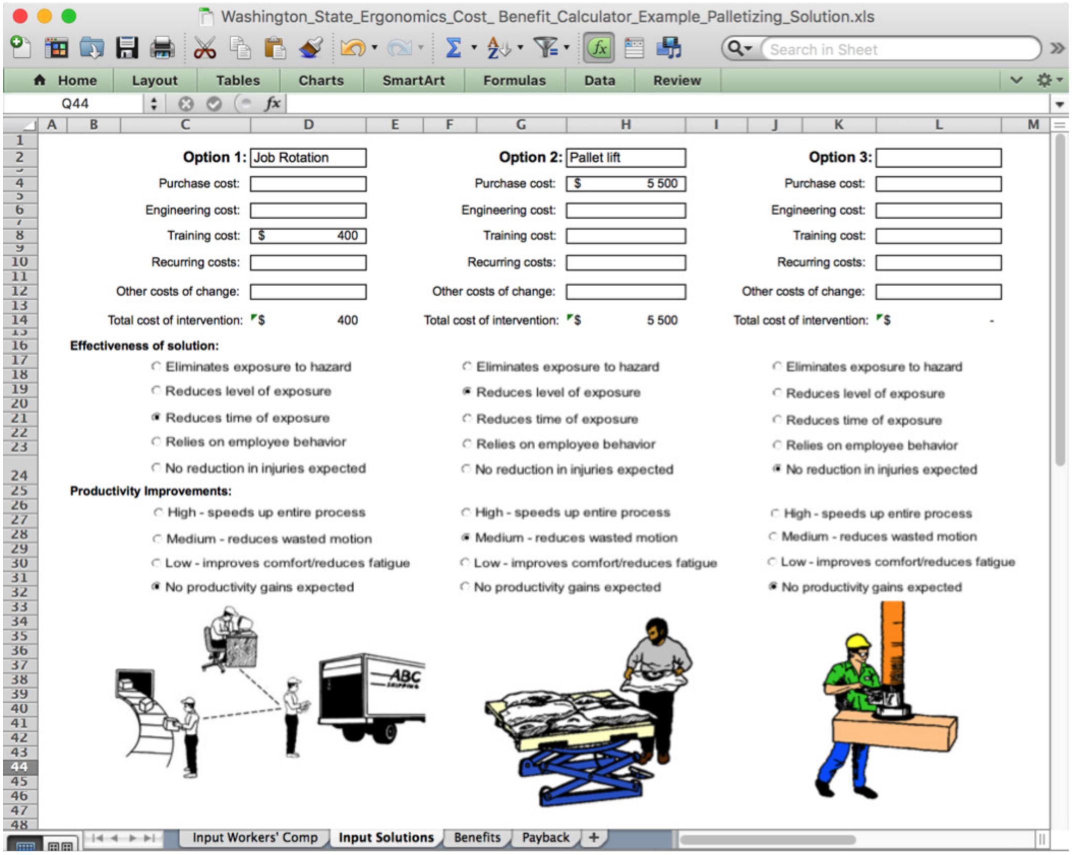


Figure 11.5: Screenshot excerpt of the Washington State Ergonomics Cost-Benefit Calculator (PSHFES, 2012). The calculator is available at http://www.pshfes.org/cost-calculator.

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11.10. Special case: a model for calculation of poor assembly ergonomics costs

With a focus on the *product quality* consequences of poor assembly ergonomics in the automotive industry, Falck and Rosenqvist (2014) have developed a product-focused calculation method that is meant for "engineers and stakeholders in the design or redesign of manual assembly solutions" (p. 140). Based on the assembly of 47,061 cars, the method calculates costs based on a found correlation between product quality errors (which led to costs in the form of scrap, blocking of production, errors, recall and repair of products, staff costs for additional efforts, customer dissatisfaction and brand devaluing) and tasks rated as having poor ergonomics.

The calculation itself looks like this (adapted from Falck and Rosenqvist, 2014 p. 144):

Costs of poor assembly ergonomics, related to products

C = total costs of manual assembly errors

W = labour cost/time unit

Costs (C):

C_{scrap} = scrap cost per item

C_{fb} = cost of errors of factory blocked cars

C_{fcomp} = cost of errors of factory complete cars

C_{rec} = cost for recall/repair of cars distributed to the customers

C_{effort} = cost of staff/time unit in additional efforts, e.g. meetings, controls, expanded staffing, etc.

C_{bw} = cost for bad will (lost brand image and customer's dissatisfaction)

WRSL = cost of work-related sick leave and rehabilitation

Number of errors (N):

N_{on} = number of quality errors online

N_{off} = number of quality errors offline

N_{au} = number of audit quality remarks

N_{yard} = number of cars in the yard awaiting repair

N_{scrap} = number of scrapped items

N_{fb} = number of factory blocked cars

Number of extra staff (N):

N_{effort} = number of people involved in additional efforts

Action time (T)

Ta_{on} = action time online

Ta_{off} = action time offline

T_{ty} = transportation time for cars in the yard to/from work shop

$$C = W (N_{on} \times Ta_{on} + N_{off} \times Ta_{off} + N_{au} \times Ta_{off} + N_{yard} \times T_{ty}) + N_{scrap} \times C_{scrap} + C_{fb} \times N_{fb} + WRSL + C_{fcomp} + C_{rec} + C_{effort} \times N_{effort} + C_{bw}$$

The calculations have components that are obviously related to automotive production (and re-work) conditions in particular, but the coverage of the indicators provide a very well-specified guide to what costs to look for.

11.11. Convincing the necessary people

When trying to implement ergonomics programs it is necessary to convince and communicate with a number of stakeholders throughout the company, especially the decision makers who have the majority of power:

- investors
- managers
- operators
- logisticians
- sub-contractors, suppliers
- health and safety group
- unions

For the majority of stakeholders, discussions focused around costs is the most convincing way to present the case. There are three different types of cost, all of which should be used when presenting the case (Zandin, 2001):

- historical costs
- projected savings
- actual cost savings

Historical costs relate to the issues that have already occurred due to poor ergonomics, such as time and money lost due to prolonged periods of sick leave. Introducing the problem with such costs alongside some relevant statistics and complaints from workers provides a credible foundation to present your case. It enables stakeholders to understand that the current approach is problematic and should be modified. Projected savings can be estimated using various cost calculation tools based on knowledge of historical costs and assumptions. Providing stakeholders with projected savings can be particularly beneficial during the prioritization of which new projects to take on and the decision-making process. Following the ergonomic intervention it is then possible to identify actual cost savings. These savings should be compared with the projected savings so assumptions can be validated and modified if necessary. These savings can be used as case studies for future ergonomics interventions both within the company and externally, helping to spread awareness of the economic value of ergonomic interventions.

In addition to presenting cost benefits, other potential improvements should also be highlighted. Such as improved working atmosphere with more motivated staff and improved company reputation, attracting a larger pool of perspective employees.

11.12. The power to implement change

Once the stakeholders have agreed to implement an ergonomics project, it is important to carry out the change in a logical and holistic way to maximize gains and clearly demonstrate positive the effects of the change. The latter can be done by making sure to present the change in an attractive way so that all levels of involved stakeholders, from management to worker, are aware of the original reason for the change process itself, as well as the short- and long-term effects of it. By utilizing the knowledge you have gained in ergonomics and work design, you can highlight different perspectives of how the change play out for different stakeholders, such as pointing out how the work is easier and more efficient for workers, stating to management which unnecessary losses have been avoided, etc. Making sure to record the impacts of the intervention help you build up your own library of "success stories" that can increase trust among other stakeholders in the improvement proposals that you suggest.

Study questions

Warm-up:

Q11.1) Name at least three individual-level costs of poor workplace ergonomics.

Q11.2) When a company loses an employee to sick leave, what are the potential "hidden" costs that can be incurred?

Q11.3) What industrial costs can result from poor assembly ergonomics?

Q11.4) When a company makes an investment in a workplace change targeting ergonomics, what are some examples of expected gains that the investment can be balanced against?

Look around you:

Q11.5) Find two ergonomics intervention case study descriptions (for example, you can find them by using the sources quoted in section 11.2.3) and compare – what were the expected economic gains, and how was the return on investment accounted for in the case study?

Q11.6) (Continuation of the previous question) Compare what kinds of problems were identified in the case studies as impacting economic performance, how the intervention was designed to address the problem, and what outcomes were measured to prove whether the intervention was successful in an ergonomic and economic sense.

Connect this knowledge to an improvement project

- If you are drafting a suggestion for a workplace design change or ergonomics intervention, find an example of a similar case study (preferably describing a similar intervention or implementation) and use it as an example of the proven benefits in another setting – this proof-of-concept may help you argue for the proposal being a good idea also in the context you are addressing.
- When calculating the impacts of an investment, include as many different economically related safety, productivity and efficiency aspects as you can think of. Think of both long- and short-term impacts on the operations of the workplace and/or the company's output capacity.
- Remember to emphasize impacts both on the individual, team and company levels if possible. Starting with a small implementation that proves successful may pave the way for larger investments in the future.
- Use a sensitivity analysis to calculate a more modest prognosis of the gains – this will help to convince sceptical stakeholders that the investment is not too optimistic.

Connection to other topics in this book:

- Using digital human modeling (Chapter 9) and model representations of the workplace to gain worker input and acceptance for changes (Chapter 6, section 6.5) are cost-effective ways to test alternative solutions without exposing workers to risk or wasting money, materials and time on solutions that are unsuccessful.

- A socially sustainable workplace (Chapter 13) tends to enable and encourage workers to stay at a workplace and over time develop skills and knowledge that make them even more valuable to the employer – knowing how to keep these employees safe and motivated is a long-term economic investment in any company's future.

Summary

- Research and several case studies show that a strong link exists between a good work environment and company profits.
- Poor ergonomics leads to a number of costs for individuals, society and companies.
- Adopt a language of economics when trying to convince stakeholders to invest in proactive ergonomics efforts.
- Utilizing a proactive approach considering ergonomics from the projects outset provides significant cost benefits compared with a reactive approach.
- Building awareness of the proven benefits of ergonomics programmes can be done through case studies and training.
- A number of tools and cost calculation methods can be used to quantify ergonomics benefits. Some are targeted at a particular aspect of cost, such as sick leave, product-related losses, payback time, etc.

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