

Employee empowerment in reducing production error amount in sheet metal fabricating industry

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1. Introduction

Results from earlier field study [1] indicate clearly that most of the problems in the production flow of sheet metal part fabricating case factories are closely related to human work and human errors. In this situation these companies are losing an appreciable portion of profit within reach due to poor workmanship and direct human made errors. Development activities must therefore be focused to the development of employee skills or to the development of work organization.

1.1. Origins of production errors in case factories

Results from study [1] indicates that most of the production errors in each case factories belong to the "human activity based errors – category". The figures are 68.8% of all production errors in factory A, 84.9% of all production errors in factory B and 70.4% of all production errors in factory C.

The second largest category is the "manufacturing technology based errors – category". The figures are 21.7% of all production errors in factory A, 9.7% of all production errors in factory B and 16.0 % of all production errors in factory C.

"Material based errors – category" is the smallest in factory A (0.6% of production errors) and the second smallest in factory B (5.4% of all production errors) and in factory C (5.5% of all production errors).

1.2. Objective and scope of this paper

The objective of this paper is to investigate in theory how *employee empowerment* could be used in reducing the overall production error amount in sheet metal component fabricating industry based on background information collected in previous study [1]. Also the level of empowerment is discussed in three case factories from previous study [1]. Furthermore, suggestions for production error reduction in case factories are considered in this paper.

2. Theory of workforce empowerment

The idea of organizational learning has been present in the management studies literature for decades, but it has only become widely recognized in 1990's [2]. The notion of organizational learning is essentially based on individual learning, and it is hypothesized that organizational learning and applications of organizational learning will benefit the long-term performance of the organization. Through learning, organizations adapt to change, avoid

repeating past mistakes, and retain critical knowledge that would otherwise be lost [3].

Mabey and Salaman [4] suggest that the learning organization is often a piece of shorthand to refer to organizations which try to make a working reality of such desirable attributes as flexibility, teamwork, continuous learning and employee participation and development. Popular management techniques that are often associated to learning organization are for example quality circles, reengineering, total quality management and empowerment [5].

Employee involvement is a strategy that firms use to give employees more responsibility and accountability in performing their jobs. It is based on the principle that people will support ideas or decisions that they helped form, and that people who actually perform the work have valuable insight into the inner workings of operations that are not always known to managers. One technique of employee involvement is the use of empowerment. Empowerment involves pushing the authority to make decisions down to the first level of qualified people in the organization [3].

Empowerment evolved because of technological advances, increased global competition, and better educated employees. Technology allowed the supervision and control once maintained by managers to be exercised by lower level employees having access to systems, knowledge, and information. New global economics has created the need for managers to be more involved in strategic planning. It has also called upon the firms as a whole to be responsive to cultural factors, which empowerment facilitates [3].

In the literature the term empowerment is generally used to refer to the autonomy on the job, education and training of different skills, support and information sharing as well as pay system that link pays with performance [6-8]. All those are important factors strongly related to learning organization.

At its simplest, according to Wilkinson [9], empowerment would commonly be associated with the redistribution of power, but in practice empowerment is usually seen as a form of employee involvement, designed by management and intended to generate commitment and enchain employee contributions to the organization [9].

Maurer [7] expresses that people are empowered when they are given the authority and responsibility to make decisions affecting their work with a minimum for interference and second-guessing by others. When people are empowered they bring their minds to work and they are engaged in making decisions that affect their part of the business. They take responsibility for their actions and

work free from the petty bureaucratic hassles that diminish value and waste time. They also add value to the organization by embracing the principles of quality and service as well as search for ways to make a difference.

Smith [10] writes that to empower is to give power, open up and to release potential of people. In Smith's terms it can be viewed as a commonsense activity. Typically, it embraces job involvement, job enrichment and participation of people in various forms, including suggestion schemes. Essentially, the main trust of empowerment is through having greater autonomy on how jobs are done, carrying with it immense potential for improving productivity have been pointed.

According to Adeleye et al. [6], empowerment means providing employees with the dynamic knowledge and skills required in manipulating and operating advanced machines, as well as increasing employee relevance.

Shannon's [11] definition for empowerment is "the personal potential of employees and the cultural climate for employees to co-create a workplace they personally believe in and thrive in". Empowerment:

- is the function of two variables: potential and opportunity;
- is the process of people working together to co-create quality of work life and work output;
- touches one at ones core, allowing one to co-create something one personally believes in.

With empowerment not existing as a single unified entity, it can cover a very wide range of schemes, which in turn may involve a variety of diverse management motivations. However, sharing a common assumption that employees and employers interests are inextricably connected unites them. They can range from the mechanistic (i.e. structural change) to the more organic (connected with attitude/culture) [9].

Empowerment is no quick fix according to Smith [10]. It is about significant cultural change, which requires time and real commitment. For many organizations the introduction of empowerment will both require and ultimately cause a major cultural shift. It can only be effective when it is linked to the organization's values; values for which people need to feel a large measure of ownership.

This paper identifies five most important themes related to employee empowerment as found in published papers. These themes and references are described in Table 1.

Table 1 (continuation)

Theme	Reference (e.g.)
Information sharing	Civerolo, 1992 [8]
	Greif, 1991 [17]
	Hammuda and Dulaimi, 1997 [18]
	Karlsson and Åhlström, 1996 [13]
	Maurer, 2000 [7]
	Pegels, 1998 [3]
	Randolph, 1995 [14]
Upward problem solving	Smith and Mouly, 1998 [15]
	Willis, 1997 [16]
	Bessant and Caffyn, 1997 [19]
	Civerolo, 1992 [8]
	Karlsson and Åhlström, 1996 [13]
Education and training	de Leede and Looise, 1999 [20]
	Pegels, 1998 [3]
	Willis, 1997 [16]
	Adeleye et al., 2001 [6]
	Civerolo, 1992 [8]
	Duncombe et al., 1993 [12]
	Karlsson and Åhlström, 1996 [13]
Reward system	Pegels, 1998 [3]
	Randolph, 1995 [14]
	Smith and Mouly, 1998 [15]
	Smith, 1997 [10]
	Willis, 1997 [16]
	Born and Molleman, 1996 [21]
	Civerolo, 1992 [8]
Milner et al., 1995 [22]	
Reward system	Smith and Mouly, 1998 [15]
	Smith, 1997 [10]
	Willis, 1997 [16]
	Willis, 1997 [16]

2.1. Multifunctional team structure

A multifunctional team is a group of employees who are able to perform many different tasks. These teams are often organized along a cell-based part of the production flow. Thus, each team is given responsibility of performing all the tasks along this part of the production flow meaning that the number of tasks in the group increases [13].

Teams make it possible for people to participate in decision making and implementation that directly affects them. Teams help all members of the organization feel responsible for co-creating a workplace they can believe in and thrive in [11].

One consequence of the use of multifunctional teams is that the number of job classifications decreases. Instead of having different employees performing only a limited number of tasks, the aim is to have employees who are able to perform more than one task in the team. Tasks previously performed by indirect departments are now responsibility of the team. These tasks can include material handling, material control, maintenance and quality control [13].

Sykes et al. [23] have listed many positive results achieved by the use of multifunctional teams. These results are based on the studies in Norway and Sweden. Most important results are that autonomous working groups (teams) often result in rising product quality and work groups (teams) can have improved problem solving abilities. Work groups (teams) can also have greater worker motivation, increased participation and more power equalization.

Table 1

Five themes related to employee empowerment

Theme	Reference (e.g.)
Multifunctional team structure	Adeleye et al., 2001 [6]
	Civerolo, 1992 [8]
	Duncombe et al., 1993 [12]
	Karlsson and Åhlström, 1996 [13]
	Maurer, 2000 [7]
	Pegels, 1998 [3]
	Randolph, 1995 [14]
	Shannon, 1991 [11]
	Smith and Mouly, 1998 [15]
	Smith, 1997 [10]
	Wilkinson, 1998 [9]
Willis, 1997 [16]	

2.2. Information sharing

The organization must clearly communicate the company's vision, strategy, objectives, goals and directions [8]. People who are closest to the work must have immediate access to the tools and information they need in their work [7]. Information is important in order for the multi-functional teams to be able to perform according to the goals of the company. The objective is to provide timely information continuously, directly to the production flow [13].

Empowered individuals need to be given frequent and constructive feedback on their performance [10]. They need to be reminded where they started, where they have been and how far they have come. Baselines must be agreed upon, to define success and provide milestones for monitoring progress. To avoid confusion later on, it is important to define these up front, as well as knowing how the measurements will be taken. Visions can serve as the context for feedback. A clear sense of vision and mission allows us to have humility to recognize that we need other's perspective to improve those areas where we are not perfect [16].

The means of visual communication can and must be used. They offer effective tool for company to communicate with employees. Visual communication can be used for example in documentation, production control, quality control, process indicators and making the progress more visual [17].

2.3. Upward problem solving

There is the old paradigm that says, "Workers work and managers think". This paradigm must be replaced with a new paradigm where everyone is a problem solver. People who have been doing their job for years know the problems best [8].

Everyone should be involved in the work of improvement and problem solving [13]. Employees have to know and accept that it is their turn to be creative in solving problems and finding better ways of doing things. This includes accepting the responsibility to govern ourselves as individuals and as parts of teams in harmony with agreements we have made, holding people accountable for results, and being a source of help to them in achieving those results [16].

Tools that can be used in upward problem solving scheme are continuous improvement (e.g. [19] and [20]) and formal suggestion schemes [13].

A quality circle is an activity where operators gather in a group to come up with suggestions on possible improvements. An elaborate scheme for implementing suggestions, rewarding employees and feeding back information on the status of the suggestions is tied to this. This can be contrasted with the traditional suggestion scheme where individual employees are encouraged to leave suggestions in a suggestion box [13].

2.4. Education and training

The number of tasks in which employees receive training should increase. Training should be given in statistical process control, quality tools, computers, performing set ups, carrying out maintenance, etc. Also, the employees should be trained in a number of functional areas. Tasks previously performed by indirect departments should now

be the responsibility of the team. Training in such areas as material handling and control, purchasing, maintenance and quality control should become essential point [13].

Training should become an ongoing event, not a once a year course [16]. Knowledge and sight of the "bigger picture" is an essential requirement of empowerment. Obvious thought it may seem each individual need to have a clear understanding of his or her job and how it relates to the organization's mission. Coupled with mission is the need for inspiring visions, which can help raise expectations of success [10].

Problem solving tools and techniques are important instruments in quality control. These tools and techniques include for example flow charts, cause and effect diagrams, control charts, run charts, brainstorming, histograms and check sheets.

Without understanding these tools and techniques, the teams and individuals will be unable to separate the symptoms of the problems from the root causes of the problems [8].

2.5. Reward system

The cornerstone of empowerment is to congratulate, to reward (no financially) and to recognize people for a job well done and also, to promote their specific accomplishments. This has to be done in such a way that people throughout the organization can see the results that were achieved. This positive action will help defuse the perception that performances measurements are only to be used to catch the people doing something wrong [8].

Non-financially reward system [8, 16, 22] and financially reward system [21] are both supported in published papers. Yet, the importance is in no financially reward systems.

3. Method to examine the level of empowerment in case factories

To estimate what is the level and the state of the empowerment in the case factories, an empowerment survey was completed. Sixteen questions (Q1 - Q16) were asked from a representative of every case company. These questions are based on five main types of themes in employee empowerment (Table 1).

Multifunctional team structure.

Q1: Is a multifunctional team organization in use?

Q2: Is supervisor-level in use in the organization or is there a team leader system?

Q3: Is task rotation in use? How often does this happen?

Q4: Are different functions integrated in the tasks of the teams? (Purchasing of articles, quality control and control of all working hours, and so on).

Information sharing.

Q5: What is the content of the information communicated with the employees? (Vision, strategy, objectives, goals and directions, and so on).

Q6: Are public performance indicators in use?

Q7: How and where is the information displayed?

Q8: Are the means of visual communication in use?

Upward problem solving.

Q9: Who is responsible for developing the production activities?

Q10: Is formal suggestion scheme in use?

Q11: Is a continuous improvement program in use?

Education and training.

Q12: Are continuous training and education methods and activities in use?

Q13: What is the content of the training?

Q14: Are problem solving techniques taught to the staff?

Reward system.

Q15: Is a reward system in use?

Q16: What performance meters are used in the reward system?

4. Results

Results of the empowerment survey are presented in Table 2.

Table 2

Results from empowerment survey			
	Factory A	Factory B	Factory C
Q1	no; workgroups / cell production	yes; three separate work teams in use + functional organization	no; workgroups
Q2	supervisor- level	supervisor- level	supervisor- level
Q3	some tasks, e.g. machine tool operator tasks, are rotated	yes; daily basis	no
Q4	no; some tasks, e.g. purchasing of gas and sheet materials, are performed by turret punch press operators	quality control, control of working hours	no
Q5	both strategic and operative type information	both strategic and operative type information	daily matters
Q6	yes	yes; quality feedback	Some indicators in workgroup level
Q7	notice board, information leaf	info session once a week, notice board	e-mail, notice board
Q8	no	no	no
Q9	everyone in the company	supervisors	supervisors
Q10	yes; very active use	yes; poor activity	yes; poor activity
Q11	no	no	no
Q12	no; education is based on needs	yes; training program	no; basic training, education is based on needs

Table 2 (continuation)

	Factory A	Factory B	Factory C
Q13	based upon to professional needs	based upon to professional needs	based upon to professional needs
Q14	no	no; FMEA* + Pareto- methods are used by supervisors	yes; FMEA*- method
Q15	yes	yes	yes
Q16	Working time per calculated working time based on invoicing	machine tool operators cycle time	economic results, quality

*Final manufactured elements analysis

5. Analysis

Production teams are used only in factory B, where three separate teams are formed alongside the functional organization. In these teams every member performs every task and task rotation is used in daily basis. Team leaders are not used, however. Supervisor-level is still in use. Some functions are integrated in to the tasks of the teams. These functions include the control of working hours within the teams and quality control functions.

Production in factory A and factory C is very traditional and functional, although some machine tool operator tasks are rotated and some functions are integrated in the tasks of turret punch press operator operations in factory A. Noticeable is that the supervisors play a remarkable role in the operations of all the case factories.

Information is shared in very different ways in the case factories. In factory A and factory B both strategic and operative information is shared, while information shared in factory C is more linked to daily production operations. Various methods for information sharing are used in the case factories. In factory A notice board and an information leaf are used, in factory B info sessions are arranged once a week and in factory C e-mail and a notice board are used. Every factory is using some public performance meters, but the means of visual communication are not in use in any of the case factories.

The development of production activities is in response of supervisors in factory B and factory C. Only in factory A the development of production activities is in response of everyone in the factory.

A formal suggestion scheme is in use in every case factory. Only in factory A the use of a suggestion scheme is conceived active. In factory B and factory C the use of a suggestion scheme is in very low level. A continuous improvement program is not in use in any of the case factories.

In every case factory training and education is based on professional needs. Only in factory C problem solving technique (FMEA) is taught to the employees.

A reward system is in use in every case factory. Various performance meters are used. Noticeable is the minor amount of different meters in the reward system (see Table 2). In factory A and factory B only one meter is used.

5.1. Suggestions

This paper reveals that the main problems in case factories are related to the organization model, absence of visual communication and proper production development tools that involve everyone in the factory to the development process. This paper also suggests that real multipurpose training and education is missing in case factories and meters used in a reward system are not supportive enough to production development activities.

It can be claimed justifiably that real employee empowerment is in comparatively low level in the studied case factories. Every case factory has both good and less good sectors when empowerment is inspected as entirety but all sectors must, however, be taken into consideration when totally empowered employees are aimed at.

Comparable results have been published earlier. Ollikainen and Varis [24] have studied employee empowerment in the Finnish sheet metal industry in their paper. Their study is based on case studies performed in three Finnish case factories utilizing AMT in their production flow. The paper indicates that the employee empowerment is not in use in or is in very low level in the case factories studied in their paper. Their paper suggests that the main problems are associated with a failure in organizational adoption. The organizational models in the studied companies are very rigid and the foreman level is clearly in use. In most cases employees perform only one task in the production flow, performance measurement indicators and customer feedback are not used as tools and there are few continuous improvement activities in all the factories studied.

6. Discussion

The current empowerment situation in case factories can partly be explained by examining the boom in the sheet metal part fabricating industry in Finland during 1990's. The boom started in the first part of the 90's and it was boosted mainly by the telecommunication and electronics industry. In the situation of the time, sheet metal part based products were produced at increasing pace and the most important factor became that there were enough production. Huge investments were made in the production machinery and human and organizational factors were considered as secondary matters. Enough cover was provided even with the higher production costs caused, e.g. by the production errors. The efficiency of the production system was not used as a competitive weapon.

With the employee empowerment direct and indirect human errors in the production flow can supposedly be affected. The employee empowerment functions mentioned earlier in this paper can be used in each case factory to improve the existing situation. It can be expected that the employee empowerment make reductions in the overall amount of the production errors in the production flow of constructions based on fabricated sheet metal parts possible. It also can be claimed that more can be done in current situation by investing in the employee empowerment than investing in a new manufacturing technology in the case factories studied.

A number of investigators have shown in theory that worker skill levels are a direct determinant of levels of

quality performance [25, 26]. Also, many published papers about the learning organization and the employee empowerment can be found. However, one observation is that there is very little detailed discussion about the real scores of a success achieved with the employee empowerment and learning organizations particularly in the manufacturing engineering (notice [23]) and most of the papers are based on literary surveys.

Some comparable and trend setting information can however be found. Significant improvements in productivity (through improvements in quality, reduction in scrap and waste, reduction in throughput time and greater flexibility to respond to needs) and a competitive advantage of employers and the nation as a whole have been reported as an economic benefits of training organizations [27, 28, 29]. The United States Department of Labour [30] has further reported that formal worker training introduced in 180 manufacturing firms in the United States increased overall productivity by 17 % in three years when compared to industries that did not introduce any training program. The department of Labour also reported that another survey of 157 small manufacturers observes a drop of 7 % in scrap and increase of 20 % in the productivity of production workers. Also comparable information can be found from the results of empowerment mainly in the specific area of health care industry [31, 32] but these cases cannot be generalized in the area of manufacturing engineering.

A book by Easterby-Smith and Araujo [2] backs up this observation of the lack of real empirical results in the field of learning organization. Easterby-Smith and Araujo report in their book that many authors including [33-35] have bemoaned the shortage of empirical work in the field of organizational learning for a long time. Even recently there are no signs of the pattern changing. As an example, Easterby-Smith and Araujo have studied 150 papers on the learning organization abstracted in ABI Inform during 1997 and found out that only 15 (10 per cent) were based on new empirical data collected by the authors, and of these, ten were based on investigations carried out by the authors themselves.

There is also some disbelief about the promises of learning organization and however, it is understandable, following some documented failures in implementing such desired changes as self-managed teams, high commitment work systems, total quality management or organizational learning, e.g. [36-38].

This paper cannot adequately verify the efficiency of the employee empowerment on reducing the production errors especially in the case factories but it will stay as a matter of belief. However, it can be assumed that it has no negative influences on the amount of production errors. Mital et al. [39] also back this opinion by finding that the skills of the employees determine the effectiveness and the efficiency of the process of manufacturing and the quality of goods produced.

To gain empirical results in the area of the employee empowerment particularly in the manufacturing engineering it is necessary to start a documented development project that concentrates on collecting empirical data from the results of empowerment activities. Only after doing this it will be possible to verify the influence of the empowerment activities.

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DARBUOTOJŲ PASTANGŲ ĮTAKA MAŽINANT
GAMINIŲ IŠ METALO LAKŠTŲ GAMYBOS
PAKLaidAS

Re z i u m e

Straipsnyje teoriškai nagrinėjama darbuotojų pastangų įtaka gamybos paklaidoms. Ieškoma būdų, kaip darbuotojų pastangomis sumažinti plonalakščio plieno gamybos paklaidas. Remiantis gamyklų duomenimis tirtas sukurto metodo patikimumas.

Darbuotojų pastangos tiesiogiai ar netiesiogiai siejamos su žmogaus klaidomis gamybos srautuose, kurie, kaip manoma, gali būti vienaip ar kitaip šių klaidų paveikti. Galima tikėtis, kad darbuotojų pastangos mažina paklaidų skaičių metalo lakštų gaminių gamybos srautuose. Įmonėse atliktų tyrimų duomenys rodo, kad daugiau investuojant į darbuotojų pastangų įtakos tyrimus galima pasiekti geresnių rezultatų negu investuojant į naujas gamybos technologijas.

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EMPLOYEE EMPOWERMENT IN REDUCING
PRODUCTION ERROR AMOUNT IN SHEET METAL
FABRICATING INDUSTRY

S u m m a r y

In this paper employee empowerment is investi-

gated in theory. Focus has been made on reducing the overall production error amount in sheet metal component fabricating industry by means of workforce empowerment. In this paper also the level of empowerment is examined in case factories.

With the employee empowerment direct and indirect human errors in the production flow can supposedly be affected. It can be expected that the employee empowerment make reductions in the overall amount of the production errors in the production flow of constructions based on fabricated sheet metal parts possible. It also can be claimed that more can be done in current situation by investing in the employee empowerment than investing in a new manufacturing technology in the case factories studied.

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ВЛИЯНИЕ УСИЛИЙ РАБОТНИКОВ НА
УМЕНЬШЕНИЕ КОЛИЧЕСТВА
ПРОИЗВОДСТВЕННЫХ ПОГРЕШНОСТЕЙ
ИЗДЕЛИЙ В ПРОМЫШЛЕННОСТИ ЛИСТОВОЙ
СТАЛИ

Р е з ю м е

В статье теоретически рассматривается влияние усилий работников на уменьшение производственных погрешностей в промышленности листовой стали. Исследовано надежность разработанного метода на основе данных с предприятий.

Усилия работников прямо или косвенно связаны с человеческими ошибками в потоках производства, которые, как предполагается, могут быть одним или другим способом обусловлены упомянутыми ошибками. Можно считать, что усилия работников уменьшают количество производственных погрешностей изделий в потоках промышленности листовой стали.

Результаты исследований, полученные в предприятиях, подтверждают идею, что путем изучения усилий работников и делая определенные инвестиции в этой области, можно достичь лучшие результаты чем при инвестициях в новые производственные технологии.

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