

Participatory Ergonomics as a Method of Quality Improvement in Maintenance

Małgorzata Jasiulewicz-Kaczmarek

Poznan University of Technology, Faculty of Management Engineering
11 Strzelecka Str., 60-965 Poznan, Poland
malgorzata.jasiulewicz-kaczmarek@put.poznan.pl

Abstract. Modern enterprises are forced to constantly improve ways of management and to introduce changes. One of the changes is a alteration of organizational culture and acceptance of participation of employees in designing and implementing new solutions. Striving for general improvement of system efficiency involves joint design of technical and social systems to achieve the best fitness to goals and requirements of system and its parts possible. Not only technical objects, but also workers and workplaces (work environment) require keeping in good condition. Such approach to maintenance stresses human importance and workers place in systems they work in. It also stresses necessity for not engineers, but also quality and ergonomics experts as well as technical objects users to involve into maintenance actions and processes. The paper presents potential of participatory ergonomics to maintenance quality improvement use.

Keywords: maintenance, participation, participatory ergonomics, stakeholders.

1 Introduction

Improvement is an undertaking striving for gaining extra benefits for both, organization and its customers. Usually in literature on the subject, the term is presented in pro-quality activities context – ‘continuous improvement’ and most authors associates the term with Japanese methods of effectiveness and efficiency of organization activities for the benefit of internal and external customers improvement. According to the definitions by S. Piersiala and S. Trzcielinski presented in [1], continuous improvement is planned, organized and systematic process of continuous change for the purpose of losses elimination/limitation, as well as productivity and competitiveness improvement, requiring commitment of employees on all the levels of organization structure.

Hence, improvement is solving problems, which are both, discrepancies (differences) between requirements and results (effects), and searching for opportunities/possibilities to improve effectiveness and efficiency of actions and processes [2]. Thus, to improve, the knowledge of processes (or objects analysed) and of methods and tools that can be applied, as well as skills in using them, is necessary.

In contemporary company the maintenance function has become an integral part of the overall profitability of an organization. It has been proven that with no doubt maintenance as support function in businesses is crucial for companies performance and new strategies i.e. lean manufacturing, just-in-time production, total quality control and

six-sigma programs implementation (see: [3], [4], [5], [6], [7]). Thus, improving levels of utility and efficiency of actions and process performer in UR system [8] is necessary. Many organisations tend to adopt the proactive maintenance philosophies such as total productive maintenance (TPM) and reliability-centered maintenance (RCM), since these approaches are committed to long-term improvement of maintenance management. The basic rules of contemporary maintenance concepts/ approaches (TPM, RCM, etc.) include:

- Top managers commitment,
- Team work, active communication and cooperation between all the interested parties (participation),
- Pro-preventive orientation, based on searching for and eliminating potential threats and their causes,
- Trainings and qualifications and skills of employees improvement,
- Joining operators in maintenance actions, delegating responsibilities and powers,
- Methods of work, work environment and safety improvement.

The goal of the paper is to present opportunities and potential benefits from quality of maintenance improvement (from both internal and external perspective) that can be achieved with participatory ergonomics.

2 Participation Aspects

Improving quality and efficiency of actions and processes of maintenance system requires joint (combined) design of technical and social subsystems¹. Not only technical objects (tools, machines etc.) should be kept 'in shape', condition of work environment and people performing processes – company's employees, is even more important. The approach to maintenance presented above is human-centric, focusing on people and their place in the system analysed. It also stresses the necessity to join experts on quality and ergonomics, and not only engineers, in maintenance improving actions. Safety, satisfaction of employees, quality of professional work and mood (disposition) of employees are positively synergetic in maintenance system, which means that total efficiency of a system is much bigger than a sum of its parts (components).

Contemporary concepts of maintenance management show necessity to join all the process parties and performers in improving actions, they stress importance of participation and team work.

Wenger [9] refers to participation as 'a process of taking part and also to the relations with others that reflect this process'. It is a complex process that includes, for example, doing, talking, thinking, feeling and belonging. Participation involves action, e.g., talking with someone, and connection, e.g., feeling that one takes part.

Participation method is more and more often used in companies to improve ergonomics of work and workplaces – participatory ergonomics. It is an important factor promoting initiatives of employees and high efficiency in implementing actions

¹ Maintenance system is socio-technical (social subsystem includes individuals (people) and social groups, organizational culture they create, as well as goals, tasks and organizational strategy, while technical subsystem includes machines, tools and Technologies, as well as actions taken to perform the tasks).

improving work methods, work conditions and risk management (see: [10], [11], [12]). The literature presents numerous definitions of participatory ergonomics (see [13], [14], [15], [16]). The common characteristic is that in a change process, attention is paid explicitly to the role of participants [17]. Participants of improving changes can be divided into two groups: internal stakeholders, including:

- top management, their commitment and role is usually strategy, goals and budget definition (when changes are local and not cost-generating, the top-management role is small),
 - middle management, usually regarded as the head of the department where the changes really took place,
 - employees, their commitment is crucial for success of the project/ undertaking, They know how the work is done normally and how the improvement works with respect to their typical work. They are necessary when it comes to taking decisions on changing work method or realisation or implementing new organisation because they usually know what is wrong and how to implement changes,
 - experts, they are necessary at the stage of problem analysis, solution choice and solution testing,
- and external stakeholders, including:
- facility management, sector organizations, clients and suppliers, they define their requirements, show necessity to implement changes, provide knowledge and skills (f.ex. trainings).

Their role and commitment in particular stages of participatory improving changes design can be different. According to [17] in participatory ergonomic project, ergonomists and employees play an essential role in the improvement process ('ergonomists (or other experts working on work improvement) are involved, because they add a new realistic vision and employees are involved because of changes in their work—and they may know best what and how to change').

Though the role of ergonomists and employees is indisputable, nowadays the role of facility management, sector organizations, clients and suppliers in initiating improving changes in organizations they cooperate with is more and more often appreciated and stressed in business practice.

3 Maintenance Stakeholders and Their Requirements

Maintenance system is a set of organizational units and relations between them defined by maintenance processes accordingly to technologies accepted and used. Combination of maintenance actions and repeated actions striving for processing inputs into outputs is a maintenance process (ISO/IEC 15288 (2002)). Applying process approach to organize maintenance system actions allows to meet the most important needs of contemporary organization: pro-customer orientation (in maintenance case it is direct orientation on internal client and indirect orientation on external client), changes implementation (improvement) and barriers between departments crossing (maintenance actions are performed not only by maintenance department employees, but also production, supplies an some other department employees) [18].

The ISO 9000:2005 standard defines clients as 'an organisation or a person receiving the product'. The definition by Juran and Blanton [19] is wider, as it defines client

as ‘anyone who is affected by the product or by the process used to produce the product’. Clients (both internal and external) are also stakeholders (stakeholders – person or group having an interest in the performance or success of an organization (example: customer, owners, people in an organization, suppliers, bankers, unions, partner or society) (ISO 9000:2005). In the following paper, when analyzing an organization as a system (a set of elements and relations between them) the term ‘stakeholder’ will be used instead of the term ‘client’ as to improve maintenance quality it is necessary to identify stakeholders interested in maintenance system, as well as relations between them since they are supposed to enable appointing a common, general goal and motivate to active cooperation – participation – striving for the goals appointed achievement.

Maintenance should be analysed in two perspectives:

- internal perspective, in which maintenance system is analysed in reference to meeting obligations towards employees (process performers) and other internal processes of the company (maintenance system in the aspect of processes performed by the company and relations between them – processes aspect)²,
- external perspective, in which maintenance system is regarded as management system and analysed in reference to meeting obligations towards environment as well as values, methodologies and tools used to perform management functions.

Maintenance internal perspective is a perspective of internal stakeholders while external perspective is a direct perspective of external stakeholders and indirect perspective of internal stakeholders. Taking both perspectives into consideration allows to identify present and future (potential) problems and to choose proper tools supporting their solution, and thanks to stakeholders identification it allows to build responsible and competent teams.

Importance and positive influence of internal perspective of maintenance improving project is widely discussed in literature on the subject, external perspective is taken into consideration only in a small degree.

3.1 Internal Maintenance Perspective

Maintenance exists, because disregarding the branch of a company and products it provides, it has resources (technical objects) which need to be maintained. Maintaining means making the technical object perform tasks and actions defined by their user. Hence, the goal of maintenance is guaranteeing that technical objects fulfill their functions and their performance meets the requirements of their operators. Realization of the goal above mentioned depends mostly on active participation and commitment of the operators (employees) and managers.

As maintenance system works for internal clients, the goal of maintenance should be defined to meet general requirements of internal client and then decomposed to meet specific requirements of maintenance processes and workstations (as presented in Figure 1), where:

P_1, \dots, P_n – maintenance processes,

S_1, \dots, S_n – workstations.

² „Internal client’s satisfaction provides perfect quality, because if an organisation meets the needs of its clients and enables its internal clients performing their tasks, then the organisation (the net of internal clients) cooperates for clients (internal and external) [20].

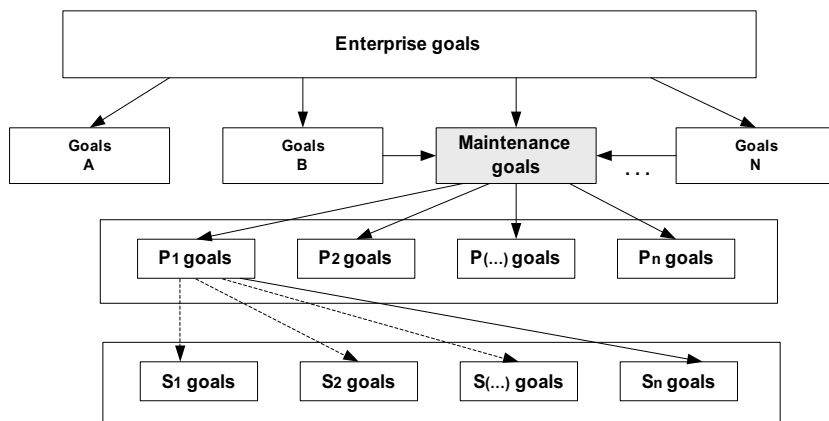


Fig. 1. Maintenance goals structure

Goals identified and presented to the employees, along with necessary resources provided and properly managed, are maintenance tools.

Continuous integration of enterprise management systems is the reason why maintenance systems lost organizational autonomy they had so far and became an element of internal chain of stakeholders: production – quality – maintenance [21] (relation presented in Figure 2).

As the requirements of the internal system's stakeholders are continuously changing, the goals are changing as well. The changes include time, processes realization and working conditions [22]. The concept of “working conditions” consists of two dimensions: “conditions of work,” describing the practical conditions under which people work and cope with a specific technical and organizational environment, and “conditions of employment,” describing the rules and status under which people are employed and trained.

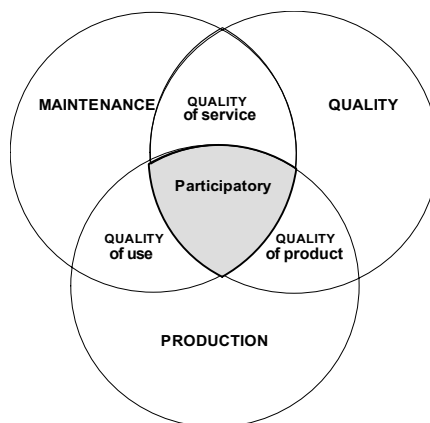


Fig. 2. Maintenance and internal stakeholders

The result of actions improving working conditions is employees' well-being, which includes job satisfaction, motivation, organizational commitment and job involvement. Each well organized, goal-oriented process in which people take part, should provide human well-being as one of its outputs, hence processes are performed by people and their improvement is mostly in exploiting people's capacity and turning from simple communication to interactive communication and commitment – participation (communication is critical to achieving genuine participation). Each of the stakeholders should be aware not only of realization of goals of processes take part in, but also of processes of suppliers and clients, as they are internal stakeholders. Internal quality of services is interpreted with people's attitude to each other and the way they help one another. It is one of the aspects of quality culture of organizations, culture inside organization influences how the services for its employees are performed.

By including internal perspective of maintenance, quality and ergonomics into improving actions better integration of human and systems is provided and the central role of the user in systems design is stressed. A key principle of participatory ergonomics is that workers are the experts in what they do. Therefore, maintenance workers should be involved in the identification and analysis of hazards in the workplace, and the development of solutions that could reduce these hazards.

Work environment plays the main role in preventing discordances and in provoking discordances in maintenance system. The factors provoking maintenance discordances are believed to be: procedures (f. ex. complex, unrealistic, out of date and out of range), equipment (f. ex. Lack of proper equipment, equipment that does not meet requirements), knowledge (f. ex. lack of knowledge, trainings, experience), work organization (f. ex. problems with communication between workers, lack of teamwork), time pressure (f. ex. rush, misdefined maintenance schedules), however designing and realizing trainings can limit the mistakes and failures above mentioned and their consequences as well. To achieve this, it is necessary to build teams and support their work with experts, both internal and external, advice.

An example:

A middle-sized company of mechanical branch employs 123 workers. In the company, two teams were appointed, both including production workers and maintenance workers. There was also safety and hygiene of work expert taking part in both teams' works. For both teams he organized and realized training on workplace hazards and risk connected with their previous routines. The task for the teams was to analyse actions (workplace preparation) as they were realized so far. There were two meetings every week in three months time. After each meeting a report including suggestions for changes and potential benefits was prepared. The outcome of teams work was following:

- Analysis of hazards and potential risks during operations, thanks to which unnecessary actions were identified, operations order was changed and necessary tools were identified, as well as supervision rules,
- Modification of old reports and the way they were filled in, rules of communication process in case of failure existing or potential (expected),
- Responsibilities ranges for operators were developed, as well as instructions for workplaces (for both, operators and maintenance workers).

Result of changes implemented were assessed on the meeting of both teams after six months. According to employees, they believed in possibility to implement changes themselves and they were ready to accept more responsibility. Employees have learned to evaluate the improvements and are able to choose and evaluate the consequence of changes in the workstation and organization. The work and environment limit some possibilities, but the employees have enough control to change the work. They tested various new ways of working and workstations, and could experience how it works. This positive experience could have played a role in the success.

3.2 External Maintenance Perspective

Improving quality of actions and processes in organizations should closely connected with needs and expectations of external stakeholders as the performance of an organization depends upon the interaction between business functions and stakeholders both within and outside of the company. External integration of processes performed by a company becomes the more important, the more important supply chain in which the company takes part in is. Organization's ability to provide clients with products meeting their requirements is as important as product's technical features, and the ability seems to accurate infrastructure and competent, satisfied workers. Organization's stakeholders are, in many cases, integrators of engineering best practices, and they believe sharing knowledge and improving supply chain processes are their duties.

In food branch companies, pharmaceutical companies and automotive industry stakeholders participation is a common standard, and training programmes are oriented, besides from technical issues, also on building proper relations between stakeholders, care for work environment and quality of life at work. Participation of ergonomics and quality are believed to be the basic element of delegating and receiving responsibilities and rights of workers. Consequence in 'managed development' realization is reflected in the following sentence 'my benefit is your benefit' and in the following question 'what can be done to make me happy thanks to your satisfaction?'.

4 Summary

The paper presents two aspects of including participatory ergonomics to maintenance quality improving set of methods. The first aspect is internal perspective of maintenance and its place in the structure of processes performed by a company. The second is the external perspective, in which maintenance system and its improvement is strictly connected to needs and expectations of external stakeholders. Because of growing importance of relations between an organization and its stakeholders (f. ex. in food and pharmaceutical industry), the second perspective seems to be very important. Though initially maintenance seems to be important for stakeholders only indirectly, author's work as an expert in design, implantation and exploitation of pro-quality systems and as an auditors in stakeholders audits has proven that most of discordances and notices is on infrastructure supervision not only in technical, but usually in social aspects. The consequence is increasing commitment of stakeholders in internal processes improvement. Teams of workers, initiated by organization partners, in which experts appointed by organization partners participate in changes implementation, are more and more

common. Managers usually do not speak on participatory ergonomics, but they use it. The most important is that thanks to changes implemented in participative way companies build new organizational culture based on awareness of common goals, responsibilities and competences, in which workers feel safe (both physically and psychically) and are appreciated.

References

1. Piersiala, S., Trzcieliński, S.: Maintenance Systems. In: Fertsch, M., Trzcieliński, S. (eds.) *Koncepcje zarządzania systemami wytwórczymi*, pp. 114–126. Publishing House of Poznan University of Technology (2005)
2. Brillman, J.: *Nowoczesne koncepcje zarządzania*. PWE, Warszawa (2002)
3. Pun, K.F., Chin, K.S., Chow, M.F., Lau, H.C.W.: An effectiveness-centred approach to maintenance management. *Journal of Quality in Maintenance Engineering* 8(4), 346–368 (2002)
4. Cua, K.O., McKone, K.E., Schroeder, R.G.: Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. *Journal of Operations Management* 19(6), 675–694 (2001)
5. Hansson, J., Backlund, F., Lycke, L.: Managing commitment: increasing the odds for successful implementation of TQM, TPM or RCM. *International Journal of Quality & Reliability Management* 20(9), 993–1008 (2003)
6. McKone, K.E., Schroeder, R.G., Cua, K.O.: Total productive maintenance: a contextual view. *Journal of Operations Management* 17(2), 123–144 (1999)
7. All-Najar, B.: Cost –Effective & Continous Improvement of Production Process and Company's Business when using Total Quality Maintenance (TQMmain). In: *International Conference on Maintenance Engineering*, ChengDu, China (2006)
8. Murthy, D.N.P.: Strategic maintenance management. *Journal of Quality in Maintenance Engineering* 8(4), 287–305 (2002)
9. Wenger, E.: *Communities of practice: Learning, meaning, and identity*. Cambridge University Press, Cambridge (1998)
10. Zalk, D.M.: Grassroots ergonomics: initiating an ergonomics program utilizing participatory techniques. *The Annals of Occupational Hygiene* 45, 283–289 (2001)
11. Kawakami, T., Kogi, K.: Action-oriented support for occupational safety and health programs in some developing countries in Asia. *Int. J. Occup. Safety Ergon.* 7, 421–434 (2001)
12. Hignett, S., Wilson, J.R., Morris, W.: Finding ergonomic solutions—participatory approaches. *Occup. Med.* 55, 200–207 (2005)
13. Wilson, J.R.: Solution ownership in participative work redesign: the case of a crane control room. *Int. J. Ind. Ergon.* 15, 329–344 (1995)
14. Wilson, J.R., Haines, H.: Participatory ergonomics. In: Salvendy, G. (ed.) *Handbook of human factors and ergonomics*, 2nd edn., pp. 490–513. Wiley, Chichester (1997)
15. Kuorinka, I.: Tools and means of implementing participatory ergonomics. *Int. J. Ind. Ergon.* 15, 365–370 (1997)
16. Haines, H., Wilson, J.R., Vink, P., Koningsveld, E.A.P.: Validating a framework for participatory ergonomics. *Ergonomics* 45, 309–327 (2002)
17. Vink, P., Imada, A.S., Zink, K.J.: Defining stakeholder involvement in participatory design processes. *Applied Ergonomics* 39, 519–526 (2008)

18. Jasiulewicz-Kaczmarek, M.: "Process approach" in maintenance. In: Fertsch, M., Grzybowska, K., Stachowiak, A. (eds.) *Logistyka i zarządzanie produkcją – nowe wyzwania, odległe granice*, pp. 260–270. Publishing House of Poznan University of Technology (2007)
19. Juran, J.M., Blanton, G.A.: *Juran's Quality Handbook*. McGraw-Hill, New York (1999)
20. Zairi, M.: Managing customer satisfaction: a best practice perspective. *The TQM Magazine* 12(6), 389–394 (2000)
21. Pawłowski, E., Pawłowski, K., Wachowski, M.: Komputer Aide Maintenance Systems. In: Fertsch, M., Trzcieliński, S. (eds.) *Koncepcje zarządzania systemami wytwórczymi*, pp. 104–113. Publishing House of Poznan University of Technology (2005)
22. Jasiulewicz-Kaczmarek, M.: Macroergonomic design for improved quality performance in maintenance, *Foundations of Control and Management Sciences*, vol. 11, pp. 171–183. Publishing House of Poznan University of Technology (2008)