

## DIMENSIONS OF THE RELATIONSHIP BETWEEN ERGONOMICS AND QUALITY IN MANUFACTURING: A REVIEW

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**Abstract:** This study explored dimensions of relationship between ergonomics and quality in manufacturing context. Role of ergonomics in achieving freedom from error and employee motivation in manufacturing and implementation of ergonomics into quality systems were elaborated. Pertinent case studies were reviewed. Need for experimental analysis of the link between ergonomics and quality was emphasized.

**Keywords:** *Quality, Ergonomics, Manufacturing*

### 1. Introduction

Ergonomics and quality interact in manufacturing. Many authors agree that while good ergonomics results in higher quality performance, existing quality systems facilitate ergonomic improvements such as better work conditions or enhanced occupational safety (Drury, 1997, Taveira *et al*, 2003, Eklund, 1997). It is pointed out by many authors that experimental studies demonstrating quantified, concrete effects of ergonomics on quality are needed (Drury, 1997, Govindaraju *et al*, 2001, Hagg, 2003). In this respect, objective of this study is twofold; to elaborate dimensions of the relationship between ergonomics and quality in manufacturing and to review pertinent case studies.

### 2. Ergonomics and Quality in Manufacturing

Quality in manufacturing has two determinants; product quality in design and freedom from deficiencies in manufacturing processes. Failure to meet a product specification in manufacturing results in a non-conformity or a defect. Hence, quality in manufacturing turns out to be degree of conformance to determined specifications and *freedom from deficiencies* becomes a key issue in achievement of high quality. To build and maintain processes which are *free from deficiencies*, employees should be strongly motivated. Thus, *motivation* is another key issue to attain high quality in manufacturing. In this respect, relationship between ergonomics and quality in manufacturing was elaborated in two directions; *freedom from deficiencies* and *motivation*.

Given the quality requirements are determined in manufacturing, any reason causing a *non-conformance to these requirements* is an *error* and *freedom from deficiencies* becomes *freedom from errors*. Human, the central focus of ergonomics is the main source of *error* in quality concept and it is not possible to exclude humans from manufacturing thoroughly (Govindaraju *et al*, 2001). Ergonomics provides necessary body of knowledge about *error theory* and methods to assure *freedom from error* in manufacturing processes (Drury, 2000, Eklund, 1997). Schwind, (1996), suggests that poor quality in manufacturing is a symptom of problems related to ergonomics and it results from pain of worker. Govindaraju *et al*, (2001) have compiled factors that influence human performance in manufacturing and their resulting effects on quality.

Ergonomics in working conditions forms the basis for better quality (Kawecka – Endler, 1996). Eklund, (1997), reported that; adverse working conditions (e.g., insufficient lighting, vibration), repetitiveness, monotonous design of tasks, high postural discomfort and inadequately short cycle times increase human error frequency and quality deficiencies.

Gonzalez *et al* (2003), demonstrated that reduction in ergonomic problems lead to higher product quality in an ISO-9002-certified firm. Quality measures used in study were proportion of rejected parts and reprocessed parts per lot. Workers' operations were videotaped and RULA was applied (McAtamney and Corlett, 1993). The new methods were observed to reduce RULA points enabling workers to perform their task with less effort and fewer movements. New quality data showed that proportion of rejected and reprocessed parts were reduced by 45 % and 22 % respectively.

Eklund, (1995), examined relationship between ergonomics and quality in a Swedish car assembly plant. Ergonomically demanding tasks were identified, videotaped and assessed by an ergonomist and physiotherapist of the firm. Deficiency records, remarks and deficiency types were collected. Quality inspectors of the departments were interviewed about quality problems in ergonomically demanding tasks. Statistical analysis showed that relative risk of quality deficiency for

ergonomically demanding tasks was nearly three fold of other tasks. Some sort of quality deficiencies were found in 66% of ergonomically demanding tasks.

It is suggested that ergonomic improvements enhance employee motivation which is very crucial to enhance human performance (Öztürk *et al.*, 1996, Özok *et al.*, 1996). Efforts to improve workplace conditions motivate employees to contribute more to companies they work for (Kovancı, 1996). Adverse working conditions would take their toll in high employee turnover and increased error frequency, which diminishes quality performance.

### 3. Ergonomics in Quality Systems

Quality is implemented through different quality systems in corporations (e.g. ISO-9000, TQM). Successful quality movements are planned in harmony with strategic objectives of organisations. Thus, via integration of ergonomics with quality movements, ergonomics projects can be given high priorities and be managed in parallel with corporate strategies and investment plans coming down from strategic goals (Drury, 1997). According to Karapetrovic, (1999), building a separate ergonomics assurance system and integrating it with quality system is more preferable than adding specific ergonomic requirements to existing quality standards. ISO-9000 standards and TQM are two most wide spread quality systems.

Karapetrovic (1999), suggests that some ergonomics issues were addressed in 19<sup>th</sup> element of ISO 9004: part 1, "Guidelines for quality management and quality system elements", which states "*consideration be given to identifying safety aspects of products and processes with the aim of enhancing safety*". ISO 9000 system which was suggested to affect workplace improvement positively (Eklund, 1997), may function as a disciplined background for corporate change, ergonomic intervention and improvements (Karlton *et al.*, 1998). On the contrary, Eklund, (1997), suggests that some consequences of ISO 9000 such as; *more stress due to time pressure, increased responsibility without control, more physically strenuous work* are in contrast with basic principles of ergonomics in workplace.

Most of the studies on interaction between ergonomics and quality are done in TQM context. As emphasized by many authors, core of TQM is human, not quality (Kovancı, 1996, Onur and Özok, 1996), which implies the importance of ergonomics in TQM. Onur and Özok, (1996) suggested that attainment of ergonomic working conditions is prerequisite of success in TQM system. Kovancı, (1996), emphasized that successful ergonomics applications in TQM system enhance motivation. Some authors pose that TQM can be a solid ground that facilitates systematic ergonomic interventions (Drury, 1997, Karlton *et al.*, 1998). However, as with ISO 9000 systems, not all authors are in favour of TQM regarding to ergonomic improvements. Eklund, (1997), suggests that standardization and reduced creativity in TQM settings can reduce applicability of ergonomic improvements.

Öztürk *et al.*, (1996), investigated effect of ergonomics on TQM in companies located around Bursa via a questionnaire. All of the companies applying TQM and 71 % of companies planning to apply TQM claimed that ergonomic improvements lead to quality improvements. Also, 88 % of companies applying TQM have considered that ergonomic improvements increased the participation of employees to quality system.

Özok *et al.*, (1996) carried out applied ergonomics projects (AEP) program and demonstrated how ergonomics can be incorporated into TQM system through a participatory approach. AEP program began with ergonomics training given to employees by Özok. In the end of the program, ergonomic improvements were achieved in 20 items (e.g., task simplification, lifting, machine design). Özok *et al.*, (1996), reported that motivation of employees increased by the opportunity to improve their workplace and to use their own creativity in problem solving during AEP program. Authors pointed out that after AEP program, proportion of suggestions on ergonomics related problems increased by 30 %.

Small teams of employees are used as operational units in both quality and ergonomics (Drury, 1997). Though ergonomics is not a central focus in their formation, substantial portion of the problems addressed by quality circles pertain with ergonomics (Eklund, 1997). In this respect, ergonomics projects can be incorporated into TQM system as a part of quality circle applications as well as a separate program (Özok *et al.*, 1996).

### 4. Conclusions

It is widely accepted that ergonomics and quality are supplementary rather than separate issues in manufacturing (Onur and Özok, 1996, Kawecka-Endler, 1996, Drury, 2000, Eklund, 1997). However, there is a certain need to demonstrate concrete outcomes of interaction between these two concepts. Considering its substantial contributions to quality, it is clear that ergonomics could be employed as an effective tool for quality improvement in manufacturing. Thus, it is necessary to develop an

implementation model which technically demonstrates how to apply ergonomics for quality improvement in manufacturing.

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#### References

- Drury C.G.**, Global quality: linking ergonomics and production. *International Journal of Production Research*, Vol: 38, no: 17, 4007-4018, 2000.
- Drury, C.G.**, Ergonomics and the quality movement. *Ergonomics*, Vol:40, no:3, 249-264, 1997.
- Eklund J. A. E.**, Ergonomics, quality and continuous improvement conceptual and empirical relationships in an industrial context. *Ergonomics*, Vol. 40, no: 10, 982-100, 1997.
- Eklund J. A. E.**, Relationship between ergonomics and quality in assembly work. *Applied Ergonomics*, Vol. 26, (1), 15-20, 1995.
- Govindaraju M., et al.**, Quality improvement in manufacturing through human performance enhancement. *Integrated Manufacturing Systems* Vol: 12, no: 5, 360-367, 2001.
- Gonzalez B. A., et al.**, Ergonomic performance and quality relationship: an empirical evidence case. *International Journal of Industrial Ergonomics*, Vol. 31, 33-40, 2003.
- Hagg G.M.**, Corporate initiatives in ergonomics-an introduction. *Applied Ergonomics*, Vol.34, 3-15, 2003.
- Juran J.M., Gryna F.M.**, *Quality planning and analysis*. McGraw Hill, Inc, 1993.
- Karapetrovic S.**, ISO 9000, service quality and ergonomics. *Managing Service Quality* Vol:9, (2), 81-89, 1999.
- Karltun J., et al.**, Working conditions and effects of ISO 9000 in six furniture-making companies: implementation and processes. *Applied Ergonomics*, Vol.29, no:4, 225-232, 1998.
- Kawecka-Endler A.**, Modern trends formation of quality in assembling, *A.F.Özok and G.Salvendy (Edt.)*, *Advances in applied ergonomics*, USA Publishing, 859-862, 1996.
- Kovancı A.**, Toplam Kalite Yönetimi (TKY) felsefesinin yerleştirilmesinde motivasyon ögesi, 5. *Ergonomi Kongresi Bildirileri*, 655 – 662, 1995.
- Mcatamney L., Corlett E.N.**, RULA:a survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics*, Vol.24, no: 2, 91-99, 1993.
- Onur A., Özok A.F.**, Sanayide ergonomi uygulamalarına ait bir model. 5. *Ergonomi Kongresi Bildirileri*, 485- 494, 1995.
- Özok A.F., et al.**, The role of ergonomics in developing a company culture, *Özok A.F., Salvendy G., (Edt.)*, *Advances in applied ergonomics*, USA Publishing, 191-194, 1996.
- Öztürk N., et al.**, Bursa'daki endüstriyel üretim işletmelerinde ergonomik iyileştirmelerin toplam kalite yönetimine etkisi, 5. *Ergonomi Kongresi Bildirileri*, 90 – 99, 1995.
- Schwind G.**, When workers hurt, quality suffers. *Material Handling Engineering*, Vol:51 , no:4, 51-54, 1996.
- Taveira A.D, et al.**, Quality management and the work environment: an empirical investigation in a public sector organization. *Applied Ergonomics*, 34 (2003) 281–291, 2003.
- Wadsworth H.M., et al.**, *Modern Methods for quality control and improvement*. John Wiley & Sons, Inc., 2002.