Position Paper

Centre of Research
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CRE-MSD

Six Sigma: Opportunities for Ergonomics & MSD Prevention

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Six Sigma is a data driven, statistics based, industrial engineering approach to improving performance. Six Sigma tools can help in identifying issues affecting work quality, creating solutions to control process variability, and creating feedback to ensure quality is maintained, organizational output is improved, and customer expectations are met. It applies a philosophy from Total Quality Management (TQM) and has been closely connected with Lean (Wedgewood 2016)[1] because of similarities and complementary concepts. The Six Sigma concept began at Motorola in the mid-1980s (Evans, Lindsay 2005)[2] and has evolved and spread from manufacturing to other sectors, such as healthcare. Six Sigma draws on a large set of different tools and methods, while using a systematic approach to manage projects aiming to eliminate quality deficits. These tools could also be applied to reduce Musculoskeletal Disorders (MSD) risk and improve the quality of working environments. The Six Sigma approach can be an intersection point for ergonomics and engineering approaches.

Key Messages

- Six Sigma provides an opportunity to improve MSD prevention efforts.
- Elements for MSD prevention can be integrated into Six Sigma managed improvement projects and associated assessments.
- The adaptable framework and some existing tools can serve as a standalone process to investigate MSD risk using existing risk assessment approaches.
- Using approaches that are familiar to managers and engineers can help gain their support.

This position paper highlights and briefly explains some Six Sigma tools and approaches and relates these to MSD prevention and ergonomic tools. For readers wanting more details on these and other tools, you are referred to the literature (e.g. Evans, Lindsay 2005)[2] and other online resources as this list and associated information is not exhaustive due to space constraints, although not all of these tools and methods are applicable to ergonomics. This paper focuses on seven common tools or methods: Define, Measure, Analysis, Improve/Implement, Check (DMAIC); Pareto Analysis; Process Mapping; Data Collection Sheet; Fishbone Diagram; 5 Whys; Failure Modes, and Effects Analysis (FMEA); and will briefly explain the tool along with the potential connection with MSD prevention and ergonomics in general.

DMAIC – **D**efine, **M**easure, **A**nalyze, **I**mprove/Implement, **C**heck, is a standard overarching improvement process associated with Six Sigma. Each step has a prescribed function in the task of establishing process control. The MSD Prevention Guidelines use a similar investigation process flow, and practitioners likely use a similar mental model in their ergonomic assessments. DMAIC provides a formal, structured approach to the improvement process, which could be more familiar with other organization members.

Pareto analysis – The premise of Pareto Analysis is that most of the problems (80%) come from relatively few sources (20%). A Pareto chart demonstrates this by a vertical bar chart that shows the percentage contribution of problem categories to the issue, ranked from highest to lowest, with a line overlaid showing the cumulative total. This helps identify which problems to tackle first. Ergonomics information could be displayed the same way – with, for example, categories for a scenario including force, posture, time, etc. Similarly, ergonomic information could be embedded as a contributing category within a particular quality issue investigation.

Process Mapping – Process mapping provides a graphical diagram of the work flow for a process or product, demonstrating the direction of workflow, decisions, inputs, and outputs. It can be applied to the study of current and future states and could be used to identify critical ergonomic concerns in the process. An extension of process mapping is value stream mapping where value adding steps in the process or product are noted via symbols to better understand the flow of information and material. A similar approach could be used from an ergonomic perspective to identify where risk factors are elevated and increase the chance of injury or points where a review for ergonomics should be completed (Lim, Village,

Salustri, Neumann 2014)[3].

Data Collection Sheet – Also referred to as Check Sheets, Data Collection Sheets are structured sheets set up to collect and organize useful data for analysis. This style of checklist is a familiar concept for ergonomists using, for example, discomfort forms or pain surveys in current MSD prevention.

Fishbone Diagram – Also known as an Ishikawa Diagram, or Cause and Effect Diagram, the Fishbone Diagram is a tool that visually displays the connections between the root causes and the problem or defect. The standard diagram typically has "bones" on the fish skeleton representing Manpower, Machine, Methods, Materials, Measurement, and Environment with offshoots on each bone identifying contributing causes. MSD could be treated as the problem in a Fishbone analysis and ergonomic considerations could also be included in the root causes of another production issue under investigation.

5 Whys – A common problem analysis tool, 5 Whys is a simple stepwise process to determine the root cause of a problem. Users sequentially answer the question "Why?" five times to reach the root cause. A similar approach could be applied to assist with finding the root cause of a task causing injury. An ergonomic lens could also be applied to extend root cause investigations and better understand issues that are simply identified as "Human Error." Probing MSD with the 5-Why method will yield deep design and process issues that contributed to a case's hazard set.

Failure Modes and Effects Analysis (FMEA) – The FMEA is used to quantify the level of risk associated with the possible failure of a part or process. It combines information on the chance of failure, the severity of failure consequences, and the current controls in place to create a combined score that assists with prioritizing actions to manage the issue. Researchers have demonstrated the integration of ergonomics into FMEAs for design stage risk management (Village, Lin, Greig, Neumann 2011)[4].

Conclusion

Six Sigma provides another avenue to integrate ergonomics within existing organizational processes and problem solving practices. Using approaches familiar to engineers and managers can help make the ergonomics improvement efforts more understandable and increase acceptance. The seven examples provided in this paper do not cover all potential avenues for alignment with Six Sigma but pose examples of engineering tools that can be used in MSD prevention efforts. In general, the tool may either be used to analyze MSD risk directly as if it were a conventional "quality" problem, or to include MSD risks as contributing to other problems in production, such as quality deficits and errors. A common language improves the potential for increased awareness of ergonomics, which can help serve both MSD risk reduction and production quality agendas.

References

1. Wedgewood, I. (2016). Lean Sigma - A Practitioner's Guide (2nd Edition): Prentice Hall.
2. Evans, J.F., and Lindsay, W.M. (2005). An Introduction to Six Sigma & Process Improvement, Thomson/South-Western.
3. Lim, A. J., Village, J., Salustri, F. A., & Neumann, W. P. (2014). Process mapping as a tool for participative integration of human factors into work system design. European Journal of Industrial Engineering, 8(2), 273-290.
4. Village, J., Annett, T., Lin, E., Greig, M., and Neumann, W.P. (2011). Adapting the failure mode effect analysis (FMEA) for detection of human factors concerns. Proceedings of the 42nd Annual Conference of the Association of Canadian Ergonomists, London, Ontario (October 17-20).

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