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Multivariate Six Sigma: A Case Study in the Automotive Sector

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Traditional Six Sigma statistical toolkit, mainly composed of classical statistical techniques (e.g., scatter plots, correlation coefficients, hypothesis testing, and linear regression models from experimental designs), is seriously handicapped for problem solving in the Industry 4.0 era. The incorporation of latent variables-based multivariate statistical techniques such as Principal Component Analysis (PCA) [1] and Partial Least Squares (PLS) [2] into the Six Sigma toolkit, giving rise to the so-called Multivariate Six Sigma [3, 4], can help to handle the complex data characteristics from this current context (e.g., high correlation, rank deficiency, low signal-to-noise ratio, and missing values).

In this work, we present a multivariate Six Sigma case study, related to a lack of capability issue with vibration tolerances for a part of the car's brake system. We illustrate the benefits of the integration of latent variables-based multivariate statistical techniques into the five-step DMAIC cycle, achieving a more efficient methodology for process improvement in Industry 4.0 environments.

[1] S. Wold, K. Esbensen, and P. Geladi, "Principal component analysis,"Chemometrics and intelligent laboratory systems, 2(1–3):37–52, 1987.

[2] S. Wold, M. Sjöström, and L. Eriksson, "PLS-regression: a basic tool of chemometrics,"Chemometrics and Intelligent Laboratory Systems, 58(2):109–130, 2001.

[3] A. Ferrer, "Multivariate six sigma: A key improvement strategy in industry 4.0,"Quality Engineering, 33(4):758–763, 2021.

[4] D. Palací-López, J. Borràs-Ferrís, L. T. da Silva de Oliveria, and A. Ferrer, "Multivariate six sigma: A case study in industry 4.0,"Processes, 8(9):1119, 2020.

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