EMPLOYEES IN THE MIDST OF DIGITAL LEAN TRANSFORMATION: THE LITERATURE FRAMEWORK

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ABSTRACT

Manufacturing companies are urged to digitalize various production and management processes to stay innovative and competitive. As such, shop-floor employees in production plants are typically the first to face the challenge of digitalization. The topic of employees' role in the age of Industry 4.0 has been discussed in the literature, raising concerns that people will be replaced by the technologies offered by the fourth industrial revolution. More recently, digitalization studies have proposed the successful combination of work between man and machine in manufacturing plants. The lean management literature also discusses people as the main asset of manufacturing firms, where employees are the key driver for changes and improvements. However, there is a lack of discussion regarding the employees going through the digital transformation process themselves, and why some processes have been more successful than others. This study aims to evaluate a model from soft lean management practices and soft total quality management practices for digital transformation in Norwegian manufacturing companies. Furthermore, this study aims to evaluate the behaviours of employees from different management levels in the digital transformation process.

Keywords: Digital transformation, Lean management, TQM, Digitalization, Employee Behavior

1. INTRODUCTION

Research gap and questions

People in the lean philosophy are one of the pillars, where value creation, waste reductional and continuous improvement processes are highly dependent on the employee's commitment and their engagement (Liker, 2004; Slack et al., 2010; Womack et al., 1990). Poor leadership, residence to changes and lack of motivation can lead to the failure of lean implementation (Ahuja et al., 2019; Morton et al., 2019; Toledo et al., 2019; Zainuddin et al., 2019). 4.0 industrial revolution forced digital transformation, where employees remain as one of the key pillars of lean organization (Benešová and Tupa, 2017; Rauch et al., 2020; Richert et al., 2016; Stöhr et al., 2018). There is a lack of study discloses if employees, the supporters or barriers for the digital transformation, with a possible risk associated with job qualifications, new skills acquisition or the fear to be replaced by the digital technologies. The objective of the research is to investigate employees' soft factors during the times when new digital technologies are at the initial stage of implementation in manufacturing companies. Another research objective, to evaluate employees' behaviours as a reflection of digital technologies implemented in manufacturing plants. Two research questions are intended to be responded in this study:

RQ1: How employees' soft (lean and TQM) factors are influenced by the digital transformation in manufacturing plants?

RQ2: How employees' behaviours are influenced by the digital transformation?

2. LITERATURE REVIEW

2.1 Production and People

2.1.1 Lean and People

Coetzee et al. (2019) discussed the lack of framework explaining 'respect for people' lean principle. There is a difference defined between product value streams that focus attention on problems and people value streams that bring people able to solve these problems (Coetzee et al., 2019). Nagaraj et al. (2019) proposed a model with incorporated human factors in the value stream map to evaluate human factors with lean parameters. As a result, that human factor and lean implementation leads to improvement of workers' life quality and operational performance. Gaiardelli et al. (2019) proposed a model for lean implementation, taking into account the role of the human factors to achieve superior operational performance. Operational outcome is highly dependent on hard and soft lean practices, physical work environment and job characteristics. The employee behaviour outcome in combination with physical work and job characteristics is influencing the operational performance.

2.1.2 TQM and People

Agus and Selvaraj (2020), examined the importance of incorporating both technical-oriented and people-oriented Total Quality Management (TQM), where benchmarking, quality measurement and process improvement presented significant impact on production performance and productivity. Meanwhile, people-oriented dimensions such as employee focus, customer focus and supplier relations had an impact in enhancing productivity. Yan et al. (2019) proposed the framework for soft CSFs of TQM to optimise the quality management system of manufacturing companies. The quality-oriented organisational climate and innovation of supplier management concept and methods lead to better quality performance and business results. Another important aspect is a top management commitment as well as combination of quality planning with company strategy to be deployed at each level of organisation. According to Talapatra et al. (2019) human resource, strategy and the structure are the significant enabling factors in TQM implementation. Georgiev and Ohtaki (2019) discussed the importance of soft total quality management (TQM) as part of the TQM implementation process where twelve soft critical success factors (CSF) were defined and evaluated.

2.1.3 TQM and Lean

Saxena and Rao (2019) discussed similarities and variations between TQM, six sigma and lean where it was found that the concepts are complementary and should be used to strengthen the values of TQM within an organization. According to Henao et al. (2019), both JLT and TQM adoption required the social system to develop the skills and desired level of worker involvement to avoid the harmful consequences in operational and safety performance. The combination of lean practice JIT and the TQM is leading to the operational performance improvement through the support of goal-oriented practices, and increased capability in dealing with variations affecting the quality, delivery, flexibility, or cost. Romero et al. (2019) discussed TQM and quality circles in digital lean manufacturing, through the framework where quality standards vary based on their objectives and tasks dependent on human capabilities and digital capabilities. 'Respect for people' should remain as a powerful lean attribute in the age of new technologies and automation combined with human creativity, ingenuity, and innovation in a strategic way for quality planning, quality control, quality assurance, and quality improvement.

2.1.4 Employee Behaviours

Zhou and Velamuri (2018) discussed the success factors for employee innovative behaviour, as the key enablers for competitiveness. Zhou and Velamuri (2018) revealed reward and pay, cross-functional cooperation and company innovation strategy as the key factors to

foster employee innovative behavior, along with enhancing cross-functional cooperation and common goals among different units as the tactic to implement those factors successfully within the manufacturing organization. Pham et al. (2016) discovered the relations between organizational learning, top management support, innovative behaviour, employee commitment, and organizational performance and found strong links between innovative behaviour and organizational performance in the workplace. Hee and Jing (2018) examined the relationship between compensation and benefits, work-life policies, performance appraisal and training and development and employee performance, where training and development was found as the most important factor that positively influences employee performance followed by performance appraisal.

2.2 Production and digitalization

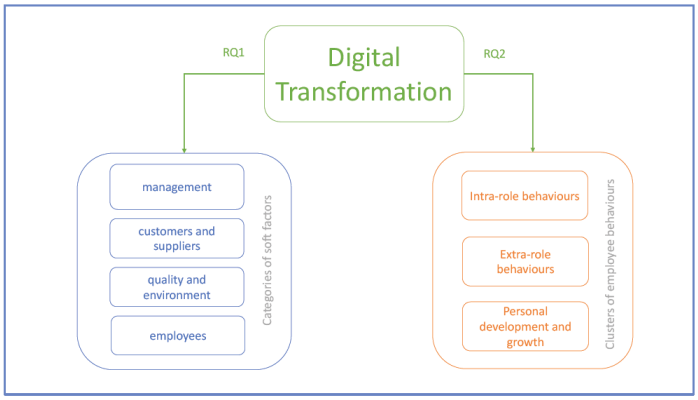
2.2.1 Sensors and Quality Control

Sensors are one of the key driving forces for innovation for smart factories and smart production where complex intelligent decisions are based on the knowledge provided with high accuracy by sensors (Schütze et al., 2018). An increasing number of sensors are being used in machine tools for self-sense, self-act, and data generation for rapid and accurate decision making. The sensors supported the smart monitoring through the graphical visualization of data and alerts when abnormality occurs in machines or tools. The information captured by sensors supports the smart scheduling through the data-driven techniques and advanced decision architecture (Zheng et al, 2018). Indri et al. (2019) discussed the importance of collaboration between humans and robots in production, which requires the smart use of sensors at different levels. There are three industrial renewing processes along with different approaches of sensors utilization sensors, such as: as a virtual sensor approach for manual guidance, a smart manufacturing solution to assist the operator's activity in manual assembly stations, and the development of an advanced robotic architecture for a flexible production line.

2.2.4 Artificial Intelligence

According to Kumar (2017) artificial intelligence (AI) is computer program that possesses its own decision making capability to solve a problem of interest and concerned with creation of a computational system that imitates the intelligent behavior of expertise. AI systems are applicable to any system that needs the replacement of human expertise, such as pattern recognition, automation, computer vision, virtual reality, diagnosis, image processing, nonlinear control, robotics, automated reasoning, data mining, process planning, intelligent agent and control, manufacturing (Kumar, 2017). Lee et al. (2018) stated analytics as a core of AI with a priority in understanding the problem and focus into solving it; understanding the system and collecting the high-quality data; understanding the parameters and characteristics of a system or process; and understanding the variety of parameters from machine to machine.

2.3 Research Model



3. SUMMARY

This paper proposes a theoretical model based on the literature reviewed. The model aims to respond two research questions contributing the study of Georgiev and Ohtaki (2019) discussing the success factors for the TQM. The paper will contribute to the research of Gaiardelli et al. (2019) discussing the hard-lean manufacturing practices, soft lean manufacturing practices and physical work environmental characteristics. The paper will contribute to Van and Nafukho (2019) research discussing the three cluster of employee environment: internal environment, job-related factors, employee related factors, intra-role behaviour, extra role-behaviour, personal development and growth. The model will serve the basis for the interviews with manufacturing companies in Norway and Sweden experincing the digital transformation in their production processes.

4. REFERENCES

Agus, A. and Selvaraj, R. (2020). The Effects Of People- And Technical- Oriented TQM On Productivity: The Mediating Role Of Production Performance. *International Journal of Business and Society*, 21 (1), pp. 234-252.

Ahuja, J., Panda, T., Luthra, S., Kumar, A., Choudhary, S. and Garza-Reyes, J. (2019). Do human critical success factors matter in adoption of sustainable manufacturing practices? An influential mapping analysis of multi-company perspective, *Journal of Cleaner Production* 239, 117981.

Alexopoulos, K. Nikolakis, N. and Chryssolouris, G. (2020). Digital twin-driven supervised machine learning for the development of artificial intelligence applications in manufacturing. International Journal of Computer Integrated Manufacturing, 33 (5), pp. 429-439.

Bai, C., Satir, A. and Sarkis, J. (2019). Investing in lean manufacturing practices: an environmental and operational perspective. International Journal of Production Research, 57 (4), pp. 1037-1051.

Baire, M., Melis, A., Lodi, M., Tuveri, P., Dachena, C., Simone, M., Fanti, A., Fumera, G., Pisanu, T. and Mazzarella, G. (2019). Wireless Sensors Network for Monitoring the Carasau Bread Manufacturing Process. *Electronics* 8, 1541.

Benešová, A. and Tupa, J. (2017). Requirements for Education and Qualification of People in Industry 4.0.

Bugdol, M. (2020). The problem of fear in TQM – causes, consequences and reduction methods – a literature review. The TQM Journal.

Coetzee, R., van Dyk, L. and van der Merwe, K. (2019). Towards addressing respect for people during lean implementation. *International Journal of Lean Six Sigma*, 10 (3), pp. 830-854.

Durairatnam, S., Chong, S. and Jusoh, M. (2019). People-Related TQM Practices, Organisational Culture, Organisational Justice and Employee Work-related Attitudes for Quality Performance: A Research Agenda. *Global Journal of Management And Business Research*, 19 (4).

Gaiardelli, P., Resta, B. and Dotti, S. (2019). Exploring the role of human factors in lean management.

García-Alcaraz, J., Flor-Montalvo, F., Avelar-Sosa, L., Sánchez-Ramírez, C. and Jiménez-Macías, E. (2019). Human Resource Abilities and Skills in TQM for Sustainable Enterprises. *Sustainability* 11, 6488.

García-Alcaraz, J., Flor-Montalvo, F., Avelar-Sosa, L., Sánchez-Ramírez, C. and Jiménez-Macías, E. (2019). Human Resource Abilities and Skills in TQM for Sustainable Enterprises. *Sustainability* 11, 6488.

García-Alcaraz, J., Realyvasquez-Vargas, A., García-Alcaraz, P., Pérez de la Parte, M., Blanco Fernández, J., Jiménez Macias, E. (2019). Effects of Human Factors and Lean Techniques on Just in Time Benefits. *Sustainability* 11, 1864.

Georgiev, S. and Ohtaki, S. (2019). Critical success factors for TQM implementation among manufacturing SMEs: Evidence from Japan. *Benchmarking: An International Journal*, 27 (2), pp. 473-498.

Halim, F., Azman, A. and Malim, M. (2019). Prioritising critical success factors of TQM in Malaysia aerospace industry using fuzzy AHP. Journal of Physics: Conference Series 1366.

Hee, O. and Jing, K. (2018). The Influence of Human Resource Management Practices on Employee Performance in the Manufacturing Sector in Malaysia. *International Journal of Human Resource Studies* 8, pp. 129-147.

Henao, R., Sarache, W. and Gómez, I. (2019). Lean manufacturing and sustainable performance: Trends and future challenges, *Journal of Cleaner Production* 208, pp. 99-116.

Indri, M., Lachello, L., Lazzero, I., Sibona, F. and Trapani, S. (2019). Smart Sensors Applications for a New Paradigm of a Production Line. *Sensors* 19, 650.

International Journal of Lean Six Sigma, 10 (1), pp. 339-366.

Iqbal, T., Jajja, M., Bhutta, M. and Qureshi, S. (2020). Lean and agile manufacturing: complementary or competing capabilities? *Journal of Manufacturing Technology Management*, 31 (4), pp. 749-774.

Kumar, L. (2017). State of The Art-Intense Review on Artificial Intelligence Systems Application in Process Planning and Manufacturing. Engineering Applications of Artificial Intelligence 65, pp. 294-329.

Lee, J. Davari, H., Singh, J. and Pandhare, V. (2018). Industrial Artificial Intelligence for industry 4.0-based manufacturing systems. *Manufacturing Letters* 18, pp. 20-23.

Lee, J., Bagheri, B. and Kao, H. (2015). A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems, *Manufacturing Letters* 3, pp. 18-23

Liker, J. K. (2004). The heart of the Toyota Production System: Eliminating waste, in The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, McGraw-Hill, New York.

Mao, S., Wang, B., Tang, Y. and Qian, F. (2019). Opportunities and Challenges of Artificial Intelligence for GreenManufacturing in the Process Industry. Engineering 5, pp. 995-1002.

Martens, R. (2020). Leadership to Lean. *IEEE Transactions on Engineering Management*, pp. 1-11

Minh, K.S., Zailani, S., Iranmanesh, M. and Heidari, S. (2019). Do lean manufacturing practices have negative impact on job satisfaction? *International Journal of Lean Six Sigma*, 10 (1), pp. 257-274.

Morton, S., Michaelides, R., Roca T. and Wagner, H. (2019). Increasing Employee Engagement in Organizational Citizenship Behaviors Within Continuous Improvement Programs in Manufacturing: The HR Link," in IEEE Transactions on Engineering Management, 66 (4), pp. 650-662.

Nagaraj, T., Jeyapaul, R.,Vimal, K. and Mathiyazhagan, K. (2019). Integration of human factors and ergonomics into lean implementation: ergonomic-value stream map approach in the textile industry. *Production Plananing and Control*, 30 (15), pp. 1265-1282.

Pham, T., Pham, C. and Pham, L. (2016). Top Management Support, Organizational Learning, Innovative Behavior, Employee Commitment and Organizational Performance of Manufacturing Companies in Hai Phong. *International Journal of Financial Research* 7, pp. 54-64.

Procedia Manufacturing 11, pp. 2195-2202.

Rauch, E., Linder, C. and Dallasega, P. (2020), Anthropocentric perspective of production before and within Industry 4.0. *Computers and Industrial Engineering* 139, 105644.

Richert, A., Shehadeh, M., Plumanns, L., Groß, K., Schuster K. and Jeschke, S. "Educating engineers for industry 4.0: Virtual worlds and human-robot-teams: Empirical studies towards a new educational age," 2016 IEEE Global Engineering Education Conference (EDUCON), Abu Dhabi, 2016, pp. 142-149.

Romero, D., Gaiardelli, P., Powell, D., Wuest, T. and Thürer, M. (2019). Total Quality Management and Quality Circles in the Digital Lean Manufacturing World. In APMS Conf. Proceedings: Towards Smart Production Management Systems, Springer, TO APPEAR.

Sancha, C., Wiengarten, F., Longoni, A. and Pagell, M. (2019). The moderating role of temporary work on the performance of lean manufacturing systems. *International Journal of Production Research*

Santhanam, N. and Srinivas, S. (2019). Modeling the impact of employee engagement and happiness on burnout and turnover intention among blue-collar workers at a manufacturing company. *Benchmarking: An International Journal*, 27 (2), pp. 499-516.

Saxena, M. and Rao, S. (2019). TQM, Six sigma and Lean. *International Journal of Applied Engineering Research*, 14 (15), pp. 3442-3447.

Schütze, A., Helwig, N., and Schneider, T. (2018). Sensors 4.0 – smart sensors and measurement technology enable Industry 4.0. *Journal of Sensors and Sensor Systems* 7, pp. 359–371.

Slack, N., Chambers, S. and Johnston, R. (2010). Lean operations and JIT, in R. D. Reid and N. R. Sanders (eds.), Operations Management, 5th edition, Pearson Education, Harlow, UK.

Stöhr, M., Schneider, M. and Henkel, C., "Adaptive Work Instructions for People with Disabilities in the Context of Human Robot Collaboration," 2018 IEEE 16th International Conference on Industrial Informatics (INDIN), Porto, 2018, pp. 301-308.

Talapatra, S., Uddin, M.K., Antony, J., Gupta, S. and Cudney, E.A. (2019). An empirical study to investigate the effects of critical factors on TQM implementation in the garment industry in Bangladesh. *International Journal of Quality & Reliability Management*.

Teryima, S. J., Timothy, A. T., Faajir, A., John, E., and Vivien, U. (2016). Motivational factors as

determinants of employee commitment and performance enhancement in profit oriented firms: A survey of selected brewery manufacturing companies in Nigeria. *International Journal of Business and Economic develo*pment, 4 (2), pp. 112-129.

Toledo, J., Gonzalez, R., Lizarelli, F. and Pelegrino, R. (2019). Lean production system development through leadership practices. *Management Decision*, 57 (5), pp. 1184-1203.

Van, H. and Nafukho, F. (2019). Employee engagement antecedents and consequences in Vietnamese businesses. *European Journal of Training and Development*, 44 (2/3), pp.

Vukadinovic, S., Macuzic, I., Djapan, M. and Milosevic, M. (2019). Early management of human factors in lean industrial systems. *Safety Science* 119, pp. 392-398.

Wang, Y., Zheng, P., Peng, T., eYang, H. and Zou, J. (2020). Smart additive manufacturing: Current artificial intelligence-enabled methods and future perspectivesm Science China Technological Science 63.

Womack, J., Jones, D., Roos, D. (1990). The Machine that Changed the World. New York: Rawson Assoc.

Yan, J., Zhang, K., Zhu, W. and Fan, Y. (2019). An empirical framework for soft CSFs of TQM in Chinese manufacturing companies. *The TQM Journal*, 31 (3), pp. 377-399.

Zainuddin, A., Kuzaiman, N., Salleh, N., Kasolang, S. and Hoffmann, J. (2019). Quality Green Lean Energy Leadership Management Practices in Malaysian Automotive Companies. *Journal of Mechanical Engineering*, 16 (1), pp. 149-158.

Zheng, P., Wang, H., Sang, Z., Zhong, R., Liu, Y., Liu, C., Mubarok, K., Yu, S. and Xu, X. (2018). Smart manufacturing systems for Industry 4.0: Conceptual framework, scenarios, and future perspectives. *Frontiers of Mechanical Engineering volume* 13, pp. 137–150.

Zhou, W. and Velamuri, V. (2018). Key contextual success factors for employee innovative behavior: A study in a foreign manufacturing subsidiary in China. *Cogent Business and Management*, 5 (1).