Available online at: http://e-jurnal.lppmunsera.org/index.php/INTECH

Jurnal INTECH Teknik Industri Universitas Serang Raya

ISSN (Print) 2407-781X ISSN (Online) 2655-2655

Improving Creative Industry Production Performance during the Covid-19 Pandemic using Cost-Based Value Stream Mapping

Sri Indrawati*, Amrullah Wahyu Adi Pratama, Umi Arief Nur'aini

Department of Industrial Engineering, Universitas Islam Indonesia, Jalan Kaliurang KM 14.5, Yogyakarta

ARTICLE INFORMATION

Article history:

Received: June 9, 2022
Revised: June 17, 2022
Accepted: July 31, 2022

Keywords

Cost-Based Value Stream Mapping
Lean Manufacturing
Production Performance

***** Penulis Korespondensi

Sri Indrawati
E-mail: sriindrawati@uii.ac.id

ABSTRACT

Improvements in creative industry production performance during the COVID-19 pandemic is urgently needed to reduce production costs. Previous research has shown that improving industrial performance during the pandemic is still minimal. Implementing the lean manufacturing method using cost-based VSM is relevant to find out the industry's current value stream performance conditions and the potential savings in production costs. This research uses cost-based VSM to improve creative industry production during the COVID-19 pandemic. Based on the research results, three types of production waste are identified, i.e., motion, transportation, and inspection. Workstations have the most significant cost, i.e., tube making, making rings, and assembling. The lean action plan is then selected using several criteria: reducing lead time, increasing productivity, improving the quality of human resources, and increasing efficiency. With Implementing the lean action plan, process cycle efficiency is expected to increase by 5%, and production costs could be reduced by 0.45%.

1. INTRODUCTION

Indonesia is one of the countries that experienced a significant decline in economic growth during the COVID-19 Pandemic. In the first quarter of 2020, Gross Domestic Product (GDP) decreased to 2.97 (Badan Pusat Statistik, 2020). The economy in Indonesia worsened in the second quarter of 2020, falling to the level of -5.32. In the third quarter, the economy rose with the new normal implementation, but still at -3.49.

These economic conditions have harmed various types of industries. About 50% of the manufacturing industry in Indonesia has decreased the amount of production (Sari & Setyaningsih, 2022). The weakening of industrial growth is quite severe in small and medium-sized industries. Almost 90% of the creative industries in 34 provinces in Indonesia stop production (Setiawan, 2020).

A strategic step is needed for each industry to survive the COVID-19 pandemic. People's low purchasing power has changed market behaviour in purchasing products based on price aspects (J. Singh et al., 2018). So, efficiency and productivity are the primary keys for every industry today.

Efficiency and productivity problems are dominated by activities on the production floor, including poor production layout, unnecessary movements, long setup times, defective products, damaged materials, and others. If quantified, about 60% of activities on the production floor have non-value added (Sable & Dakhore, 2014). Production costs will increase for things that do not provide value to the product, including production setup costs, transportation, rework and downgrading, production waste management, etc. The industry will have difficulty determining competitive product prices with high production costs.

Lean manufacturing is an approach method that is needed by the industry today. Lean is one of the business process improvement methods for creative industries (Strazdas & Cerneviciute, 2016). Implementing this method has been widely carried out in various sectors to manage production efficiently with minimal costs and production waste (Sumant & Thanki, 2014). Lean manufacturing aims to maximize customer value without additional costs and minimize inventory (Jasti & Kodali, 2015). Lean manufacturing can be implemented in two ways, i.e., identifying production waste and improving a leaner and more balanced production process (Deshkar et al., 2018; Seth & Gupta, 2005).

Value Stream Mapping (VSM) is a technique that can identify production waste and the potential for reducing production costs (B. Singh et al., 2011). VSM is a systematic visual of the current business process and shows the desired operation (Antony et al., 2017). The use of VSM in lean implementation can describe the position of production waste that has the potential to save production costs if improved (Chen et al., 2010). Using VSM, companies can identify production activities dominated by non-value-added activities, which is 90% (Fernando & Noya, 2014). VSM in Indian SMEs can reduce rework, inventory, lead time, and cycle time (Kumar et al., 2018). VSM has also been used to map energy flows to obtain an action plan to reduce energy consumption by 45.6% (Miller & Meggers, 2017). VSM is one of the appropriate lean tools for woodworking manufacturing (Chouiraf & Chafi, 2018).

The cost savings of 242.208 Rupees/year result from realizing lean manufacturing in several companies in India (J. Singh et al., 2018). Value stream analysis tools (VALSAT) are used to weight production waste so that an action plan can be obtained to reduce 8.5% the lead time and 36% the waiting time (Madaniyah & Singgih, 2017). Based on a study conducted in the metal industry, lean manufacturing is the best way to manage resources to reduce costs, time, and production waste (Goshime et al., 2019).

Lean manufacturing has been implemented in the glove industry to improve the production process using VSM and the waste assessment model (WAM) (Alfiansyah & Kurniati, 2018). The fuzzy analytical hierarchy process (FAHP) successfully prioritises obstacles and alternative action plans in implementing lean six sigma (Yadav et al., 2018). Implementing lean manufacturing through 5S, employee training, and quality control can increase the efficiency of most wood and furniture companies in Malaysia (Abu et al., 2019).

Based on this background, improving the performance of creative industry production during the COVID-19 pandemic is urgently needed to reduce production costs. A cost-based value stream can identify production costs along the value stream. Cost-based value stream, or value stream costing (VSC), can be used to identify all costs, Including material costs, employee costs, machine costs, and support costs along the value stream (Man & Răvaş, 2017).

2. RESEARCH METHODS

This study was conducted in one of the creative industries in Yogyakarta during the 19 pandemics in 2021. The chosen creative industry is the craft sector. The primary data used are product type data, production process flow, amount of material from suppliers, average customer demand, cycle time, lead time, number of workers, set up time, defect rate, number of work in process, production output, and focus group discussion results. This study is conducted using five main stages

2.1. Identify Value Stream

The craft industry business process is identified to develop a current VSM. The function of this map is a description of the current production conditions. This process is carried out by observing about 30 data randomly. After that, the calculation of production costs using cost-based VSM is carried out. Cost-based VSM or value stream costing is a technique that combines VSM and lean accounting so that the performance of industries that implement lean manufacturing can also be evaluated from a financial aspect (Abuthakeer et al., 2010). All production costs that arise upstream to downstream have several elements, i.e., production labour, production materials, production supports, construction equipment, construction supports, facilities and maintenance, and any related cost (Gunduz & Fahmi Naser, 2017). In the value stream cost analysis, the activity cost is obtained from the activity cost rate multiplied by the cycle time in the following formulation (Menon et al., 2021).

$$\sum_i Activity\ cost_{i,k,j} = \sum_i (Activity\ cost\ rate_{i,k,j}\ x\ Cycle\ time_i) \quad (1)$$

While the activity cost rate is the accumulation of operator and resource costs as shown in formulation (2). Resource costs consist of maintenance costs and depreciation of production equipment.

$$\sum_k Activity\ cost_{i,k,j} = \sum_k \left(Activity\ cost\ rate_{i,k,j}\ x\ Cycle\ time_{i,k,j}\right) \quad (2)$$

2.2. Identify Production Waste

Production waste from the current process is identified, and financial performance

http://dx.doi.org/10.30656/intech.v8i2.4805

measurements are carried out. There are eight categories of production waste in the manufacturing industry, i.e., defect, overproduction, waiting, non-utilized worker, transportation, inventory, motion, and extra processing (García-Alcaraz et al., 2014).

2.3. Analysis

Production waste analysis and its causes are carried out at this stage. The grounds are Identified by describing the reasons for waste products that should improve.

2.4. Lean Action Plan

The lean action plan is developed using the analytic hierarchy process (AHP). An evaluation of the feasibility of the solution obtained by considering industrial conditions is carried out through a focus group discussion (FGD). According to Saaty (1988), each factor that makes up the problem will be compared relatively as a basis for solving a problem. This relative comparison is made to get attention to several alternative problem decisions.

2.5. Future VSM

The performance measurement process is carried out after implementing the action plan determined in the previous stage. Performance measures used are production costs and cycle time (Hadid & Mansouri, 2014). A future state map is developed to provide an overview of the improvements that have been made.

3. RESULTS AND DISCUSSION

The object of study is a craft manufacturer in Yogyakarta that produces drum bands. This company performs make-to-order repetitive production. The drum band production process consists of receiving orders, preparing raw materials, making tubes, colouring mica for the tube body, making rings, chroming, assembling, and finishing.

In receiving orders, information is needed on the product name and the type of customization, product size, and order quantity. Furthermore, raw materials are prepared with several activities, i.e., cutting plywood and refining. The following process is the manufacture of tubes by assembling several types of size models to form 4 layers. The Mica staining process begins with making size patterns on plain mica. The colouring process is carried out up to 4 times so that the resulting colour has an even pleasing result. The ring-making process is carried out using a 0,4 cm iron plate. Then the cutting is carried out using a manual cutting tool with a medium blade.

Furthermore, the chroming process is carried out for 3-7 days. At this stage of the assembly process, mica is attached to the body, pipe and tube assembly, ring installation, and tube cleaning strings. Finishing is installing emblems, coating thinner, wrapping with bubble wrap, and packing with cardboard. After neatly wrapped and the customer's address has been written, the product is ready to be sent via cargo. The overall production process is developed in production activity mapping and can be seen in the current VSM (Fig.1).

Each stage of the production process consists of several workers, i.e., tube making consisting of 1 worker, mica for colour one worker, ring making one worker, chroming one vendor, assembling one worker, and finishing two workers. The cycle time for each production stage is the tube manufacturing work station has a cycle time of 1653.2 seconds, mica for colour is 3231.65 seconds, ring making is 2879.95 seconds, chroming is 963.5 seconds, assembly is 2751 seconds, and finishing/packing is 1070.8 seconds. The production process has a process cycle efficiency of 53.2%.

Table 1. Cost-Based VSM: Current State

Process	Operator cost (Rp/h)	Cycle Time (h)	Maintenance Cost (Rp/ h)	Depreciation cost (Rp/h)	Resource cost (Rp/h)	Activity cost rate (Rp/ h)	Material cost (Rp)	Activity cost (Rp)	Total cost (Rp)
Tube Making	63,750	0.46	3,750	30	3,780	67,530	2,250,000	31,064	2,281,064
Mica Color	63,750	0.9	12,500	595	13,095	76,845	500,000	69,161	569,161
Rings Making	63,750	0.8	37,500	4,365	41,865	105,615	1,250,000	84,492	1,334,492
Chromizing	-	0.27	-	-	-	-	500,000	-	500,000
Assembling	63,750	0.76	1,500	158	1,658	65,408	2,320,000	49,710	2,369,710
Finishing / Packing	127,500	0.3	-	-	-	127,500	50,000	38,250	88,250

Table 2. Lean Action Plan

No	Causes of Production Waste	Alternative Solution	Code
1	Length of Tubes Process	Alternative Supplier	A1
2	Length of Assembling Process	Raw Material Checking	A2
		New Standard Operating Procedures (SOP)	A3
		Maintenance Scheduling	A4
3	Duration of Ring Making	Conducting HR Training	A5
		Supervision at Work	A6
		Improvement of Production Layout	A7
		Arrange Equipment	A8

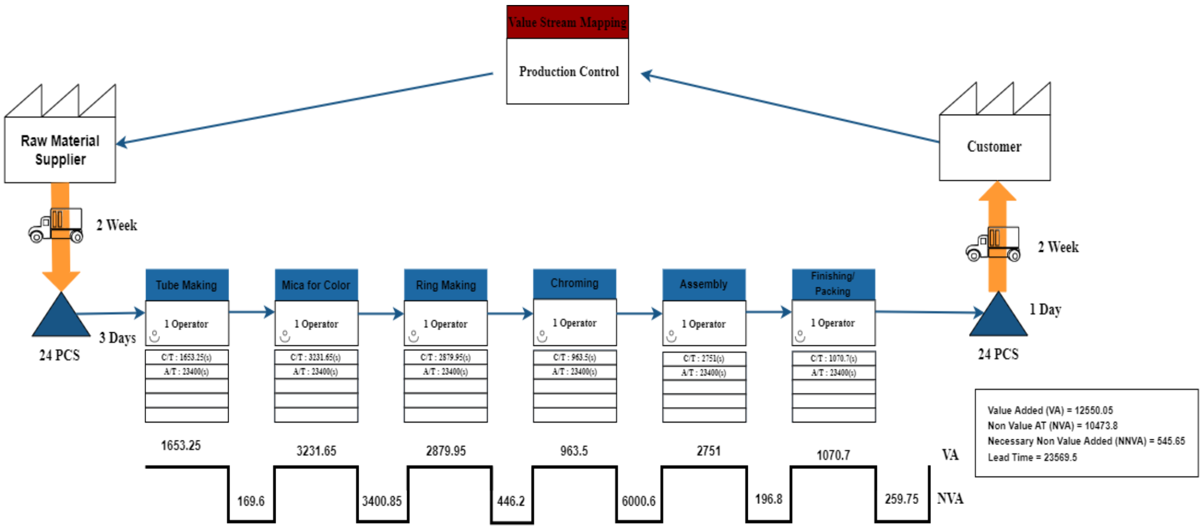

Fig. 1. Current VSM

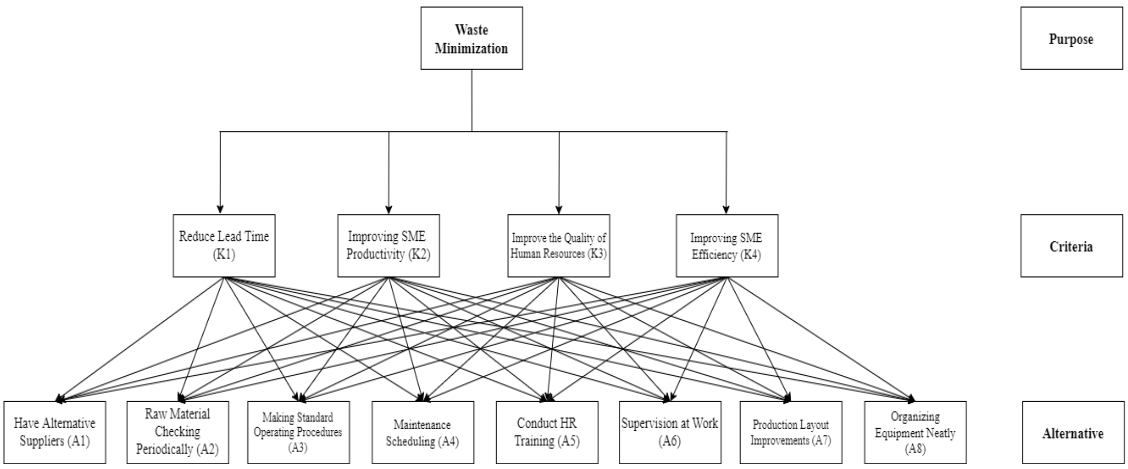

Fig. 2. Lean Action Plan Prioritization Hierarchy

Based on the current VSM evaluation, many activities are still included in NVA and NNVA activities. It can be proven by the NVA value of 10473,854 (44.44%) seconds and NNVA of 545.65 (23.15%) seconds. If NVA and NNVA activities can be reduced, the cycle time will be reduced to increase productivity. Three types of workstations have the most significant cost, i.e., tube making, making rings, and assembling, as seen in Table 1.

 http://dx.doi.org/10.30656/intech.v8i2.4805

Furthermore, a fishbone diagram considers six factors, i.e., machines, environment, assessment, methods, and materials. After the evaluation, FGD is conducted to formulate alternative solutions with the results in Table 2. The best action plan is then selected based on four criteria, i.e., reducing lead time (weight 0.241), increasing productivity (weighting 0.191), improving the quality of human resources (weighting 0.325), and increasing efficiency (weighting 0.241).

Furthermore, the calculation of the comparison of the weights between alternatives on the criteria to obtain a score/weight of the alternative weight evaluation is used to sort alternative priorities in waste minimization. Making new standard operating procedures (A3) with a score of 0.187 is the selected alternative action plan (Fig. 2).

Seven new SOPs have been successfully improved, i.e., tube manufacturing, mica staining, ring making, chroming, assembly, finishing, and packing. Based on future VSM, these new SOPs can reduce NVA activity by 11.68%, so process cycle efficiency increases by 5%. In addition, production costs can be reduced by 0.45% per production batch using cost-based VSM.

4. CONCLUSION

Based on the current VSM mapping results, there are several waste types before repairs, i.e., motion, transportation, and inspection. Three types of workstations have the most significant cost, i.e., tube making, making rings, and assembling. The lean action plan must minimize existing waste to redesign the SOP for each process. With the implementation of the lean action plan, the process cycle efficiency will increase by 5%. The cost saving derived from the Cost-Based VSM is 0.45% per production batch. This study has limitations since it concentrates on a specific creative industry with specific environments, i.e., production batch, operational processes, and other environment-based constraints. Integrating cost-based VSM with manufacturing cost estimation is another limitation. The paper's findings can be generalized to other areas to enhance knowledge.

REFERENCES

Abu, F., Gholami, H., Mat Saman, M. Z., Zakuan, N., & Streimikiene, D. (2019). The implementation of lean manufacturing in the furniture industry: A review and analysis on the motives, barriers, challenges, and the applications. *Journal of Cleaner Production*, *234*, 660–680. https://doi.org/10.1016/j.jclepro.2019.06.279

Abuthakeer, S. S., Mohanram, P. V, & Kumar, G. M. (2010). Activity based costing value stream mapping. *International Journal of Lean Thinking*, *1*(2), 51–64. https://journaldatabase.info/articles/activity_based_costing_value_stream.html

Alfiansyah, R., & Kurniati, N. (2018). Identifikasi Waste dengan Metode Waste Assessment Model dalam Penerapan Lean Manufacturing untuk Perbaikan Proses Produksi (Studi Kasus pada Proses Produksi Sarung Tangan). *Jurnal Teknik ITS*, *7*(1), 165–170. https://doi.org/10.12962/j23373539.v7i1.28858

Antony, J., Vinodh, S., & Gijo, E. V. (2017). *Lean Six Sigma for Small and Medium Sized Enterprises*. CRC Press. https://doi.org/10.1201/9781315372174

Badan Pusat Statistik. (2020). *Ekonomi Indonesia Triwulan III 2020 Tumbuh 5,05 Persen*. Badan Pusat Statistik. https://www.bps.go.id/pressrelease/2020/11/05/1738/ekonomi-indonesia-triwulan-iii-2020-tumbuh-5-05-persen

Chen, J. C., Li, Y., & Shady, B. D. (2010). From value stream mapping toward a lean/sigma continuous improvement process: an industrial case study. *International Journal of Production Research*, *48*(4), 1069–1086. https://doi.org/10.1080/00207540802484911

Chouiraf, F., & Chafi, A. (2018). Lean manufacturing for handicraft production: A new production system to enhance productivity and competitiveness of craft enterprise. *2018 4th International Conference on Optimization and Applications (ICOA)*, 1–6. https://doi.org/10.1109/ICOA.2018.8370562

Deshkar, A., Kamle, S., Giri, J., & Korde, V. (2018). Design and evaluation of a Lean Manufacturing framework using Value Stream Mapping (VSM) for a plastic bag manufacturing unit. *Materials Today: Proceedings*, *5*(2), 7668–7677. https://doi.org/10.1016/j.matpr.2017.11.442

Fernando, Y. C., & Noya, S. (2014). Optimasi lini produksi dengan value stream mapping dan value stream analysis tools. *Jurnal Ilmiah Teknik Industri*, *13*(2), 125–133. https://journals.ums.ac.id/index.php/jiti/article/view/630

García-Alcaraz, J. L., Maldonado-Macías, A. A., & Cortes-Robles, G. (2014). Lean manufacturing in the developing world: Methodology, case studies and trends from Latin America. In *Lean Manufacturing in the*

Developing World: Methodology, Case Studies and Trends from Latin America (Vol. 9783319049519). https://doi.org/10.1007/978-3-319-04951-9

Goshime, Y., Kitaw, D., & Jilcha, K. (2019). Lean manufacturing as a vehicle for improving productivity and customer satisfaction. *International Journal of Lean Six Sigma*, *10*(2), 691–714. https://doi.org/10.1108/IJLSS-06-2017-0063

Gunduz, M., & Fahmi Naser, A. (2017). Cost Based Value Stream Mapping as a Sustainable Construction Tool for Underground Pipeline Construction Projects. *Sustainability*, *9*(12), 2184. https://doi.org/10.3390/su9122184

Hadid, W., & Mansouri, S. A. (2014). The lean-performance relationship in services: A theoretical model. *International Journal of Operations and Production Management*, *34*(6), 750–785. https://doi.org/10.1108/IJOPM-02-2013-0080

Jasti, N. V. K., & Kodali, R. (2015). Lean production: literature review and trends. *International Journal of Production Research*, *53*(3), 867–885. https://doi.org/10.1080/00207543.2014.937508

Kumar, S., Dhingra, A., & Singh, B. (2018). Lean-Kaizen implementation. *Journal of Engineering, Design and Technology*, *16*(1), 143–160. https://doi.org/10.1108/JEDT-08-2017-0083

Madaniyah, R. N., & Singgih, M. L. (2017). Minimasi Waste dan Lead Time Pada Proses Produksi Leaf Spring Dengan Pendekatan Lean Manufacturing. *Jurnal Teknik ITS*, *6*(2), 301–307. https://doi.org/10.12962/j23373539.v6i2.26863

Man, M., & Răvaş, B. (2017). Integrating the Exigencies of Lean Manufacturing in the Accounting System of Lean Thinking Organizations. *Annals of the University of Petrosani Economics*, *17*(1), 139–154. https://www.upet.ro/annals/economics/pdf/2017/p1/Man-Ravas_1.pdf

Menon, R. B., Shalij, P. R., Sajeesh, P., Tom, G., & Pramod, V. R. (2021). Cost Value-Stream Mapping As A Lean Assessment Tool In A Surgical Glove Manufacturing Company. *South African Journal of Industrial Engineering*, *32*(1), 157–170. https://doi.org/10.7166/32-1-2368

Miller, C., & Meggers, F. (2017). Mining electrical meter data to predict principal building use, performance class, and operations strategy for hundreds of non-residential buildings. *Energy and Buildings*, *156*, 360–373. https://doi.org/10.1016/j.enbuild.2017.09.056

Saaty, T. L. (1988). What is the Analytic Hierarchy Process? In *Mathematical Models for Decision Support* (pp. 109–121). https://doi.org/10.1007/978-3-642-83555-1_5

Sable, C. S., & Dakhore, M. M. (2014). Reducing W aste in Production by Lean Thinking-A Case Study. *International Journal of Engineering Research & Technology (IJERT)*, *3*(6), 381–386. https://www.ijert.org/reducing-waste-in-production-by-lean-thinking-a-case-study

Sari, T. N., & Setyaningsih, P. R. A. (2022). Analisis Financial Distress dan Financial Performance Sebelum dan Selama Pandemi Covid-19 pada Perusahaan Manufaktur. *Jurnal Riset Akuntansi Mercu Buana*, *8*(1), 53–65. https://ejurnal.mercubuana-yogya.ac.id/index.php/akuntansi/article/view/2373

Seth, D., & Gupta, V. (2005). Application of value stream mapping for lean operations and cycle time reduction: an Indian case study. *Production Planning & Control*, *16*(1), 44–59. https://doi.org/10.1080/09537280512331325281

Setiawan, H. C. B. (2020). *Redesign Bisnis Pasca Pandemi Covid-19: Prespektif UMKM, BUMDes & Usaha Ekonomi Pesantren*. Mukmin Publishing. https://books.google.co.id/books?id=-JT5DwAAQBAJ

Singh, B., Garg, S. K., & Sharma, S. K. (2011). Value stream mapping: literature review and implications for Indian industry. *The International Journal of Advanced Manufacturing Technology*, *53*(5), 799–809. https://doi.org/10.1007/s00170-010-2860-7

Singh, J., Singh, H., & Singh, G. (2018). Productivity improvement using lean manufacturing in manufacturing industry of Northern India. *International Journal of Productivity and Performance Management*, *67*(8), 1394–1415. https://doi.org/10.1108/IJPPM-02-2017-0037

Strazdas, R., & Cerneviciute, J. (2016). Continuous Improvement Model for Creative Industries Development. *Transformations in Business & Economics*, *15*(2), 46–60.

https://publications.waset.org/abstracts/21169/continuous-improvement-model-for-creative-industries-development

Sumant, M. M., & Thanki, S. J. (2014). Identify the lean tool for different industrial sectors in India. *International Journal of Engineering Development and Research*, *2*(2), 2376–2379. https://www.ijedr.org/viewfull.php?&p_id=IJEDR1402173

Yadav, G., Seth, D., & Desai, T. N. (2018). Prioritising solutions for Lean Six Sigma adoption barriers through fuzzy AHP-modified TOPSIS framework. *International Journal of Lean Six Sigma*, *9*(3), 270–300. https://doi.org/10.1108/IJLSS-06-2016-0023