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Exploring Six Sigma And Lean: A Comprehensive Research Analysis

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Six sigma and lean have emerged as de facto standards for sectors and start-ups alike as a means of enhancing production and exponentially increasing the amount of consumer input received. Both of these methods are founded on the fundamental idea of enhancing processes while simultaneously cutting down on chrome-like components that do not provide anything of value to the end result. Because of this, the development of the finished product takes less time, the product itself is of higher quality, and it costs less money; all of these characteristics make it easier for customers to utilize the product, which in turn leads to increased levels of customer satisfaction. But since these methods may be used to such a wide range of procedures, it can be difficult for academics to determine which tactic is more effective in specific kinds of business settings. As a result of this, a comprehensive research, analysis, and comparison of the six sigma and lean approaches have been carried out in this work. Both researchers and system deployment engineers will find this information helpful when selecting the best practices that are commercially feasible for the underlying industry or start-up. In addition to that, the author of this article suggests a few other avenues of development that may be pursued in order to further increase the effectiveness of these strategies while they are being deployed in real time.

Index Terms **- Six sigma, chrome-like components, system deployment engineers, start-up.**

I. INTRODUCTION

There has been a significant increase in the quantity of innovative, low-cost, and widely available items on the market in recent years as a direct result of recent breakthroughs in manufacturing methods as well as the recent development of the start-up eco-system. Company executives (from this point forward, the word "company" shall refer to both established businesses and new ventures) often adhere to tight procedures to decrease costs and boost production rates in order to remain competitive in the market. As a result of this procedure, the buyer ends up purchasing a product that is not only less expensive but also of worse quality. This ultimately leads to dissatisfied customers, which in turn has a negative effect on the firms' long-term revenue. Because of the growing population and the intensifying competition in the market, the two most important things for businesses to focus on are reducing their operating expenses and boosting their production rates. Researchers have come up with a number of different approaches in order to meet these two needs. Some of these methodologies include Six Sigma, Lean, Agile, Project Management Professional, Rapid Application Development (RAD), Crystal Clear (CC), and Dynamic Systems Development Method (DSDM). All of these approaches are geared at meeting the objectives of producing a superior product and cutting down on the expenses of production. When it comes to the practical use of techniques in businesses, Six Sigma and Lean are often regarded as two of the most effective options.

Six sigma is applicable to both newly emerging and established businesses; nevertheless, the methodology relies on distinct growth hacking models depending on the kind of business. For example, the DMAIC technique (which stands for "define, measure, analyze, improve, and control") is intended for enhancing the goods that are already on the market, while the DMADV approach (which stands for "define, measure, analyze, design, and verify") is used for creating a new product. The process flow diagram for DMAIC can be seen in figure 1.a, while the flow diagram for DMADV can be seen in figure 1.b.

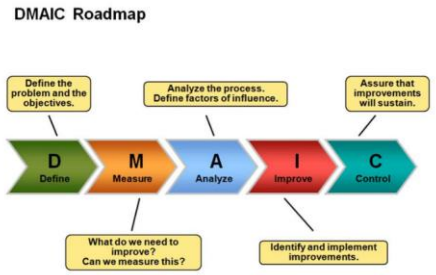

Figure 1.a. The DMAIC model

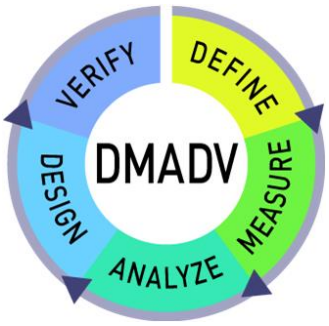

Figure 1.b. the DMADV model

In both instances, the describe stage is used to define the problem statement. The measure step is used to measure the resources, equipment, man-power, and other components. Finally, the analyze step is used to do analysis on each of these individual components. In the case of DMAIC, because the product has already been created, there is a phase for improvement and control; on the other hand, in the case of DMADV, since there is a new product, it is necessary to design and verify the product before it can go into mass production. When put together like this, each of these processes makes for a more effective cycle in the product production process.

On the other hand, the DMCEP approach, which stands for define, map, construct, establish, and perfect, is used for optimization in the lean methodology. It can be shown in figure 2, whereby the product is specified initially, then value streams are mapped; these streams are a reflection towards what components comprise the greatest value towards the product quality, and last, a process flow is produced. On the basis of this flow, features are either pulled or pushed, and ultimately, a product that is complete and flawless is developed.

Figure 2. The LEAN method

Continuous improvement is a component of each of these approaches, and it is common knowledge that by using both approaches, one may obtain an accuracy rate of 99.99996% or higher. The following section examines both the lean methodology and the six sigma methodology as they are implemented in a variety of business sectors and then evaluates the best practices that emerge from these implementations. This will allow for an analysis of the impact that lean and six sigma deployments have had. This will help the readers get a better understanding of where to use lean, six sigma, or a mix of these in order to obtain the highest possible level of efficiency from the processes that are now being used for different scenarios.

II. Methodology

There are several methods that can be used to improve worker efficiency, including:

1. Training and development: Providing workers with the necessary training and development opportunities can improve their performance and skill level.
2. Performance management: Implementing a performance management system with clear goals and metrics can improve worker efficiency and motivation.
3. Technological advancements: Investing in technological advancements can improve worker efficiency and productivity.
4. Work environment: Providing workers with a comfortable and ergonomic work environment can improve their efficiency and satisfaction.
5. Employee engagement: Increasing employee engagement and participation in decision-making processes can improve worker efficiency and satisfaction.
6. Workload and time management: Reducing workload and improving time management can improve worker efficiency and satisfaction.

7. Flexible work arrangements: Offering flexible work arrangements, such as telecommuting, can improve worker efficiency and satisfaction.
8. Workplace culture: Fostering a positive and supportive workplace culture can improve worker satisfaction and motivation.
9. Data Analytics: Using data analytics to identify patterns and trends in worker performance can inform decision making and improve efficiency.
10. Wellness programs: Implementing wellness programs such as fitness classes, mental health support and stress management can improve overall well being of the employee which results in better efficiency and productivity.
11. Clear Communication: Clear and consistent communication with employees can improve efficiency by reducing confusion and misunderstandings.
12. Recognition and rewards: Recognizing and rewarding employees for their efforts and achievements can improve motivation and efficiency.

These methods will be used in combination to create a comprehensive approach to improve worker efficiency, as different methods may be more effective for different types of workers or in different types of work environments.

III. Population of the Study

Total population will be nearly 1k to 50k users, depending upon the type of available data samples.

Sampling Method of the Study

The study makes use of a method called multi-stage sampling, which involves gradually shifting from a large sample to a more specific one by using a series of discrete steps. Utilizing multi-stage sampling as an alternative would result in cost savings.

Actual Sample Size of the study

Total sample size will be between 10k to 1 million records, depending upon availability of data sets, which can be observed from the next section of this text.

Data Collection Method

Data will be collected from the following sources,

- Employee Performance Prediction (https://www.kaggle.com/datasets/gauravduttakiit/employee-performance-prediction)
- Factory Workers' Daily Performance & Attrition (https://www.kaggle.com/datasets/gladdenme/factory-workers-daily-performance-attrition-s)
- Covid-19 Employee Productivity in India (https://data.mendeley.com/datasets/snynwg59yb)
- Employee Performance Markings (https://www.data.gov.uk/dataset/c328b504-ee6d-40c9-8fe1-fc03c39fc6bd/employee-performance-markings)
- Other Sources (https://datasetsearch.research.google.com/search?ref=TDJjdk1URjBaR0k1TUhCdWJRPT0sTDJjdk1URnhNbkV5YlhSdGJnPT0sTDJjdk1URnFkREV6YXpSNk5BPT0%3D&query=worker%20efficiency&docid=L2cvMTF0ZGI5MHBubQ%3D%3D)

All these sets will be aggregated for the purpose of this research and its findings.

IV.Analysis and Interpretation

Here, we compare and contrast the effectiveness of Lean, Six Sigma, and hybrid approaches. This aids the researchers in determining the most efficient approaches for a certain business sector and enables them to create more useful use cases. Table 1 below outlines use of these techniques across sectors and suggests ways to enhance them. Even though these approaches have already been perfected for their respective sectors, hybrid and cognitive approaches still have room to grow for different scenarios.

Method	Industry	Evaluation
6S [1]	Process Mining	6S has optimized process mining, but the system can be improved by addition of recommender systems for different processes in order to improve the output efficiency
L6S [2]	Environment aware	L6S is an optimum technique, but can be further enhanced with the help of adaptive L6S which analyses different environmental factors and then decides which method to be applied at which part of the system
Lean [3]	Oil Factory	Lean can be combined with 6S to further improve the manufacturing quality

Lean-Kaizen [6]	SMEs in general	Kaizen can be replaced with adaptive 6S in order to further optimize the process flow, and have better labour management
L6S [7]	Automotive	Very effective, does not need improvement
L6S [9]	Oil and Gas	For incremental improvement it is recommended that adaptive L6S be incorporated into the oil and gas industries
L6S [10]	Supply Chain Management	For fast decision making L6S is the best choice for this industry
6S [11]	Automotive	Use of L6S is prescribed here
6S [13]	Semiconductor	It is better to use L6S to reduce losses during the semiconductor manufacturing process
L6S [15]	Food start-ups	Food start-ups can also use concepts from adaptive L6S to optimize each modular department
L6S [19]	Bottleneck removal	It doesn't need any improvement, but can be used along with L6S for any kind of industry
L6S [23]	Iron Ores	Here adaptive L6S can be incorporated for better performance
L6S with CE [25]	General SME	Addition of cognitive intelligence reduces man power, and improves the overall process efficiency
L6S [27]	Insurance	Use of separate lean and six sigma methods can be a performance improvement for any kind of planning-based industry
L6S [30]	Software development	Both Lean and Six Sigma must be combined with adaptive cognitive intelligence for a better software management system

Table 1. Research findings from the review in terms of performance evaluation

The following section comments on these methods, and presents some interesting conclusions about the same.

Conclusion and Suggestion

Both lean and Six Sigma have value, as seen by the results of the performance analysis. While Lean emphasizes waste minimization, Six Sigma looks for ways to boost productivity. Most applications integrate Lean and Six Sigma to improve system performance and raise industrial profitability by eliminating chrome-based materials. This allows businesses to stop spending time and money trying to second-guess what their customers want. For rapid-fire decision-making, adaptive Lean Six Sigma approaches have also proved useful; for example, start-ups may employ adaptive Lean Six Sigma to boost performance and cut waste during product rollouts. A more adaptable system and a smoother flow of work and resources are both possible thanks to the incorporation of cognitive intelligence into the process. A better manufacturing process can be achieved with the use of adaptive cognitive lean six sigma, but only if the company takes the time to learn about and cater to the demands of its workforce. Finally, designers need to keep in mind that these systems are intended for human usage, thus they should always prioritize human-centric characteristics.

References

[1] S. Gao, X. Chen, J. Zhu, X. Dong and J. Ma, "TrustWorker: A Trustworthy and Privacy-Preserving Worker Selection Scheme for Blockchain-Based Crowdsensing," in IEEE Transactions on Services Computing, vol. 15, no. 6, pp. 3577-3590, 1 Nov.-Dec. 2022, doi: 10.1109/TSC.2021.3103938.

[2] N. A. Abdullah, M. M. Rahman, M. M. Rahman and K. I. Ghauth, "A Framework for Optimal Worker Selection in Spatial Crowdsourcing Using Bayesian Network," in IEEE Access, vol. 8, pp. 120218-120233, 2020, doi: 10.1109/ACCESS.2020.3005543.

[3] K. Wang, X. Li, L. Gao and P. Li, "Modeling and Balancing for Disassembly Lines Considering Workers With Different Efficiencies," in IEEE Transactions on Cybernetics, vol. 52, no. 11, pp. 11758-11771, Nov. 2022, doi: 10.1109/TCYB.2021.3070122.

[4] H. Xie and J. C. S. Lui, "Quantifying Worker Reliability for Crowdsensing Applications: Robust Feedback Rating and Convergence," in IEEE Transactions on Mobile Computing, vol. 22, no. 1, pp. 459-471, 1 Jan. 2023, doi: 10.1109/TMC.2021.3072477.

[5] X. Zhang, R. Lu, J. Shao, H. Zhu and A. A. Ghorbani, "Secure and Efficient Probabilistic Skyline Computation for Worker Selection in MCS," in IEEE Internet of Things Journal, vol. 7, no. 12, pp. 11524-11535, Dec. 2020, doi: 10.1109/JIOT.2020.3019326.

[6] J. Wang, Y. Yang, S. Wang, C. Chen, D. Wang and Q. Wang, "Context-Aware Personalized Crowdtesting Task Recommendation," in IEEE Transactions on Software Engineering, vol. 48, no. 8, pp. 3131-3144, 1 Aug. 2022, doi: 10.1109/TSE.2021.3081171.

[7] X. Cao et al., "Trajectory Penetration Characterization for Efficient Vehicle Selection in HD Map Crowdsourcing," in IEEE Internet of Things Journal, vol. 8, no. 6, pp. 4526-4539, 15 March15, 2021, doi: 10.1109/JIOT.2020.3028026.

[8] L. Wang et al., "Acceptance-Aware Mobile Crowdsourcing Worker Recruitment in Social Networks," in IEEE Transactions on Mobile Computing, vol. 22, no. 2, pp. 634-646, 1 Feb. 2023, doi: 10.1109/TMC.2021.3090764.

[9] Y. Lee, D. Beck and W. Park, "Human Factors Evaluation of an Ambient Display for Real-Time Posture Feedback to Sedentary Workers," in IEEE Access, vol. 8, pp. 223405-223417, 2020, doi: 10.1109/ACCESS.2020.3044316.

[10] J. Tang, Y. Gao and T. L. Lam, "Learning to Coordinate for a Worker-Station Multi-Robot System in Planar Coverage Tasks," in IEEE Robotics and Automation Letters, vol. 7, no. 4, pp. 12315-12322, Oct. 2022, doi: 10.1109/LRA.2022.3214446.

[11] C. Ben Issaid, A. Elgabli, J. Park, M. Bennis and M. Debbah, "Communication Efficient Decentralized Learning Over Bipartite Graphs," in IEEE Transactions on Wireless Communications, vol. 21, no. 6, pp. 4150-4167, June 2022, doi: 10.1109/TWC.2021.3126859.

[12] J. Zhang, Q. Zhang and S. Ji, "A Fog-Assisted Privacy-Preserving Task Allocation in Crowdsourcing," in IEEE Internet of Things Journal, vol. 7, no. 9, pp. 8331-8342, Sept. 2020, doi: 10.1109/JIOT.2020.2989578.

[13] F. Tang and H. Zhang, "Spatial Task Assignment Based on Information Gain in Crowdsourcing," in IEEE Transactions on Network Science and Engineering, vol. 7, no. 1, pp. 139-152, 1 Jan.-March 2020, doi: 10.1109/TNSE.2019.2891635.

[14] L. Zheng and L. Chen, "Multi-Campaign Oriented Spatial Crowdsourcing," in IEEE Transactions on Knowledge and Data Engineering, vol. 32, no. 4, pp. 700-713, 1 April 2020, doi: 10.1109/TKDE.2019.2893293.

[15] M. Wolf, A. Ketenci, A. Weyand, M. Weigold and C. Ramsauer, "Learning Factories and Sustainable Engineering—Competencies for Students and Industrial Workforce," in IEEE Engineering Management Review, vol. 50, no. 3, pp. 115-122, 1 thirdquarter,Sept. 2022, doi: 10.1109/EMR.2022.3195452.

[16] Y. Zhang, X. Zhang and F. Li, "BiCrowd: Online Biobjective Incentive Mechanism for Mobile Crowdsensing," in IEEE Internet of Things Journal, vol. 7, no. 11, pp. 11078-11091, Nov. 2020, doi: 10.1109/JIOT.2020.2994365.

[17] A. M. Ali Zakar, S. A. Naman and S. M. Ahmed, "Evaluation of the Suitability of Natural Flower Dyes Spectra on Dye-Sensitized Solar Cell (DSSC) Containing TiO2 and I-/I-3 With Respect to Stability and Efficiency," in IEEE Journal of Photovoltaics, vol. 11, no. 3, pp. 838-846, May 2021, doi: 10.1109/JPHOTOV.2021.3063017.

[18] J. Jiang, B. An, Y. Jiang and D. Lin, "Context-Aware Reliable Crowdsourcing in Social Networks," in IEEE Transactions on Systems, Man, and Cybernetics: Systems, vol. 50, no. 2, pp. 617-632, Feb. 2020, doi: 10.1109/TSMC.2017.2777447.

[19] A. Kanazawa, J. Kinugawa and K. Kosuge, "Motion Planning for Human–Robot Collaboration Using an Objective-Switching Strategy," in IEEE Transactions on Human-Machine Systems, vol. 51, no. 6, pp. 590-600, Dec. 2021, doi: 10.1109/THMS.2021.3112953.

[20] E. Troja, N. Yadav, I. Lin and N. U. Diep, "Privacy-Preserving Crowd-Sensing for Dynamic Spectrum Access With Malicious Workers," in IEEE Access, vol. 9, pp. 24234-24248, 2021, doi: 10.1109/ACCESS.2021.3057322.

[21] Y. Chen, R. S. Blum, M. Takáč and B. M. Sadler, "Distributed Learning WithSparsified Gradient Differences," in IEEE Journal of Selected Topics in Signal Processing, vol. 16, no. 3, pp. 585-600, April 2022, doi: 10.1109/JSTSP.2022.3162989.

[22] D. Wen, M. Bennis and K. Huang, "Joint Parameter-and-Bandwidth Allocation for Improving the Efficiency of Partitioned Edge Learning," in IEEE Transactions on Wireless Communications, vol. 19, no. 12, pp. 8272-8286, Dec. 2020, doi: 10.1109/TWC.2020.3021177.

[23] J. S. Ng et al., "Reputation-Aware Hedonic Coalition Formation for Efficient Serverless Hierarchical Federated Learning," in IEEE Transactions on Parallel and Distributed Systems, vol. 33, no. 11, pp. 2675-2686, 1 Nov. 2022, doi: 10.1109/TPDS.2021.3139039.

[24] K. Xue, B. Zhu, Q. Yang, N. Gai, D. S. L. Wei and N. Yu, "InPPTD: A Lightweight Incentive-Based Privacy-Preserving Truth Discovery for Crowdsensing Systems," in IEEE Internet of Things Journal, vol. 8, no. 6, pp. 4305-4316, 15 March15, 2021, doi: 10.1109/JIOT.2020.3029294.

[25] Z. Xu et al., "HierFedML: Aggregator Placement and UE Assignment for Hierarchical Federated Learning in Mobile Edge Computing," in IEEE Transactions on Parallel and Distributed Systems, vol. 34, no. 1, pp. 328-345, 1 Jan. 2023, doi: 10.1109/TPDS.2022.3218807.

[26] Y. Chen, R. S. Blum and B. M. Sadler, "Communication-Efficient Federated Learning Using Censored Heavy Ball Descent," in IEEE Transactions on Signal and Information Processing over Networks, vol. 8, pp. 983-996, 2022, doi: 10.1109/TSIPN.2022.3212315.

[27] M. Huang, V. C. M. Leung, A. Liu and N. N. Xiong, "TMA-DPSO: Towards Efficient Multi-Task Allocation With Time Constraints for Next Generation Multiple Access," in IEEE Journal on Selected Areas in Communications, vol. 40, no. 5, pp. 1652-1666, May 2022, doi: 10.1109/JSAC.2022.3143205.

[28] X. Zhang, R. Lu, J. Shao, F. Wang, H. Zhu and A. A. Ghorbani, "FedSky: An Efficient and Privacy-Preserving Scheme for Federated Mobile Crowdsensing," in IEEE Internet of Things Journal, vol. 9, no. 7, pp. 5344-5356, 1 April1, 2022, doi: 10.1109/JIOT.2021.3109058.

[29] B. Hasırcıoğlu, J. Gómez-Vilardebó and D. Gündüz, "Bivariate Polynomial Coding for Efficient Distributed Matrix Multiplication," in IEEE Journal on Selected Areas in Information Theory, vol. 2, no. 3, pp. 814-829, Sept. 2021, doi: 10.1109/JSAIT.2021.3105365.

[30] G. Ji, Z. Yao, B. Zhang and C. Li, "Quality-Driven Online Task-Bundling-Based Incentive Mechanism for Mobile Crowdsensing," in IEEE Transactions on Vehicular Technology, vol. 71, no. 7, pp. 7876-7889, July 2022, doi: 10.1109/TVT.2022.3170505.