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Enhancing manufacturing excellence with Lean Six Sigma and zero defects based on Industry 4.0

Ly Duc, M.[a,b,*], **Hlavaty, L.**[b], **Bilik, P.**[b], **Martinek, R.**[b]

[a]Faculty of Commerce, Van Lang University, Ho Chi Minh City, Vietnam
[b]Department of Cybernetics and Biomedical Engineering, Faculty of Electrical Engineering and Computer Science, VSB–Technical University of Ostrava, Ostrava, Czech Republic

ABSTRACT

Improving quality, enhancing productivity, redesigning machining tools, eliminating waste in production, and shortening lead time are all objectives aimed at improving customer satisfaction and increasing profitability for manufacturing companies. This study combines lean manufacturing and six sigma techniques to form a technique called Lean Six Sigma (LSS) by using the DMAIC (Define-Measure-Analysis-Improve-Control) model. This study proposes to use statistical test models to analyze real data collected directly from the operator. The study proposes to use the Taguchi optimization technique to determine the optimal conditions for oil dipping tanks of molybdenum materials. In addition, the study also proposes a computer vision technique to recognize objects using color recognition techniques running on the LABVIEW software platform. This study builds a digital numerical control (DNC) model operating on digital signal processing techniques, linking the data of each process together. The results reduced the rate of defective parts in the whole processing stage from 6.5 % to zero defects, the whole processing line production capacity increased by 7.9 %, and the profit of the whole production line was USD 35762 per year. As a valuable external outcome, the conclusion of the LSS project fostered a spirit of continuous improvement. The utilization of research results from the research environment in the actual production setting is significantly enhanced for the operator. The LSS model is deployed with specific tasks and targets for each member of the LSS project team, and the processing conditions for each specific stage are optimized, such as the oil dipping process and hole grinding process. Industry 4.0 techniques, including computer vision, digital numerical control, and commercial software such as LabVIEW and MINITAB, are optimized for use, simplifying machining operations. Some proposed directions for future research are also presented in detail. For example, studying the improvement of the quality of the 220 V power supply through harmonic mitigation in processing factories is an intriguing area of investigation. Additionally, exploring data security for big data in the context of Industry 4.0 would be a valuable study to enhance customer satisfaction with big data technology in the future.

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**Corresponding author:*
minh.ld@vlu.edu.vn
(Ly Duc, M.)

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Izboljšanje proizvodne odličnosti z vitko šest sigma in načelom nič napak na podlagi Industrije 4.0

Ly Duc, M.[a,b,*], **Hlavaty, L.**[b], **Bilik, P.**[b], **Martinek, R.**[b]

[a]Faculty of Commerce, Van Lang University, Ho Chi Minh City, Vietnam
[b]Department of Cybernetics and Biomedical Engineering, Faculty of Electrical Engineering and Computer Science, VSB–Technical University of Ostrava, Ostrava, Czech Republic

POVZETEK

Izboljšanje kakovosti, povečanje produktivnosti, preoblikovanje obdelovalnih strojev, odprava odpadkov v proizvodnji in skrajšanje dobavnega časa so cilji za izboljšanje zadovoljstva strank in povečanje dobičkonosnosti proizvodnih podjetij. Ta študija združuje tehnike vitke proizvodnje in šest sigma v tehniko, imenovano vitka šest sigma (LSS), z uporabo modela DMAIC (Opredelitev - Merjenje - Analiza - Izboljšanje - Nadzor). Študija predlaga uporabo statističnih testnih modelov za analizo podatkov, zbranih neposredno pri operaterju stroja, ter uporabo optimizacijske tehnike Taguchi za določitev optimalnih pogojev potapljanja molibdenovih materialov v oljne rezervoarje. Poleg tega študija predlaga tudi tehniko računalniškega vida za prepoznavanje predmetov s tehniko prepoznavanja barv, ki se izvaja na programski platformi LABVIEW in gradi model digitalnega numeričnega krmilja, ki deluje na podlagi tehnik digitalne obdelave signalov ter povezuje procesne podatke. Rezultati študije so: zmanjšala se je stopnje okvarjenih delov v celotni fazi obdelave s 6,5 % napak na nič, proizvodna zmogljivost celotne obdelovalne linije se je povečala za 7,9 %, dobiček celotne proizvodne linije pa je znašal 35762 USD na leto. Kot stranski rezultat je projekt LSS spodbudil vzdušje nenehnih izboljšav. Vpeljava rezultatov raziskav v proizvodno okolje predstavlja bistveno izboljšavo za operaterja ter za druge člane projektne skupine LSS, optimizirani pa so tudi pogoji obdelave za vsako posamezno fazo postopkov potapljanja v olje in brušenja lukenj. Tehnike industrije 4.0, vključno z računalniškim vidom, digitalnim numeričnim krmiljenjem in uporabo komercialne programske opreme LabVIEW in MINITAB so optimizirane za uporabo, kar poenostavi postopke obdelave. Podrobno so predstavljene tudi nekatere smernice za prihodnje raziskave. Na primer, preučevanje izboljšanja kakovosti 220 V napajanja z zmanjševanjem harmoničnega popačenja v predelovalnih tovarnah in raziskovanje varnosti velepodatkov v kontekstu industrije 4.0 za povečanje zadovoljstva strank, ki uporabljajo tehnologijo velepodatkov.

PODATKI O ČLANKU

Ključne besede:
Vitka šest sigma;
Industrija 4.0;
Proizvodnja;
Pametna proizvodnja;
Proizvodnja brez napak;
DMAIC (Opredelitev - Merjenje - Analiza - Izboljšanje - Nadzor);
Računalniški vid

**Kontaktna oseba:*
minh.ld@vlu.edu.vn
(Ly Duc, M.)

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