Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Framework of automated value stream mapping for lean production under the Industry 4.0 paradigm

Hao-nan WANG, Qi-qi HE, Zheng ZHANG, Tao PENG*, Ren-zhong TANG

Key words: Value stream mapping; Root cause analysis; Automated decision-making; Lean production tools; Industry 4.0

Cite this as:
Hao-nan Wang, Qi-qi He, Zheng Zhang, Tao Peng, Ren-zhong Tang, 2021. Framework of automated value stream mapping for lean production under the Industry 4.0 paradigm. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 22(5):382-395. https://doi.org/10.1631/jzus.A2000480

JZUSA

Background

In Industry 4.0, many researchers began to think about the development of a lean house. Lean production tools also need to integrate new technologies to meet the challenge caused by multi-varieties and small batches.

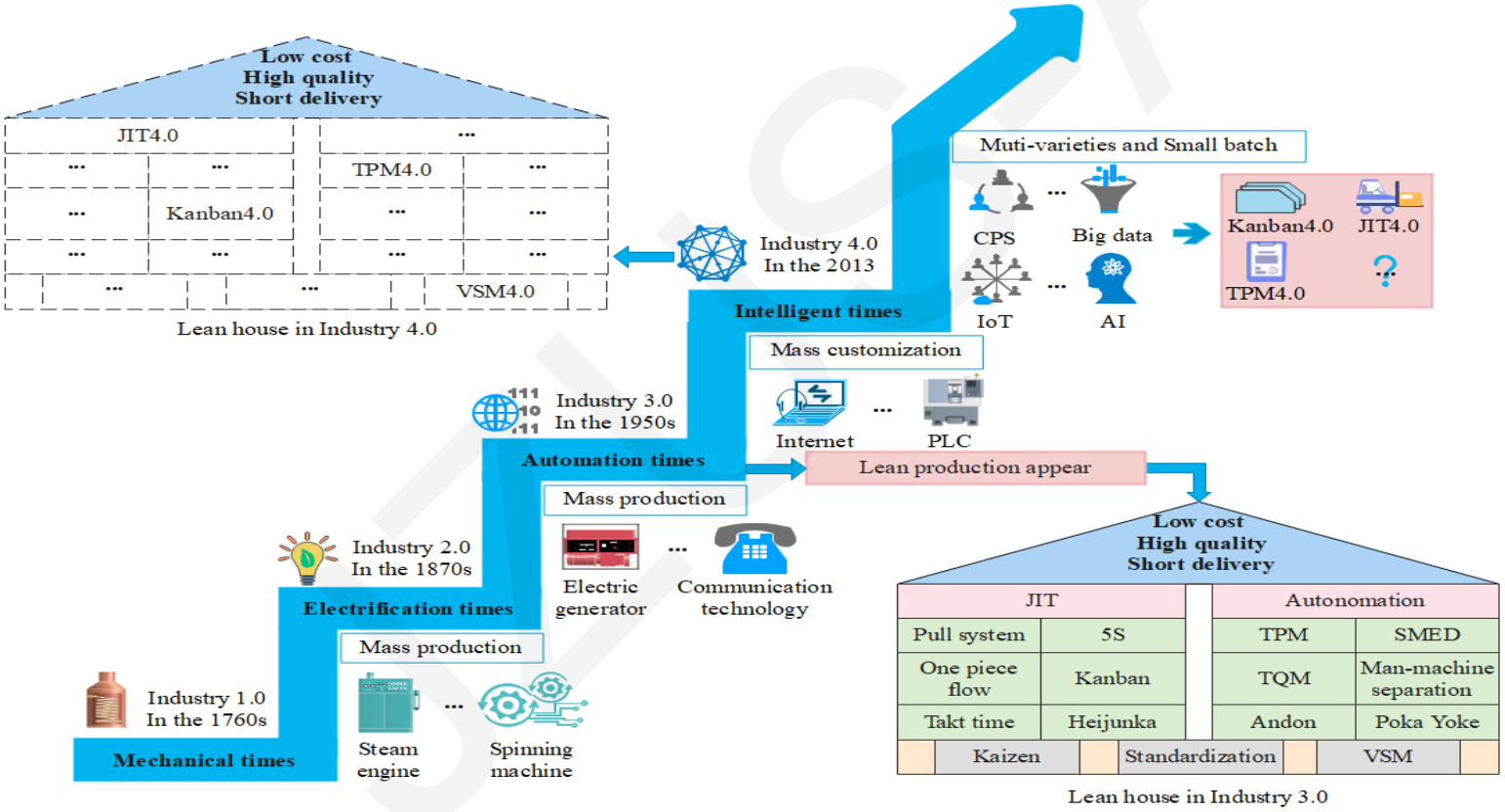


Figure 1. The development of lean production tools in Industry 1.0-4.0

Highlights

A systematic framework of automated value stream mapping (VSM) is proposed to rejuvenate traditional lean tools in Industry 4.0.

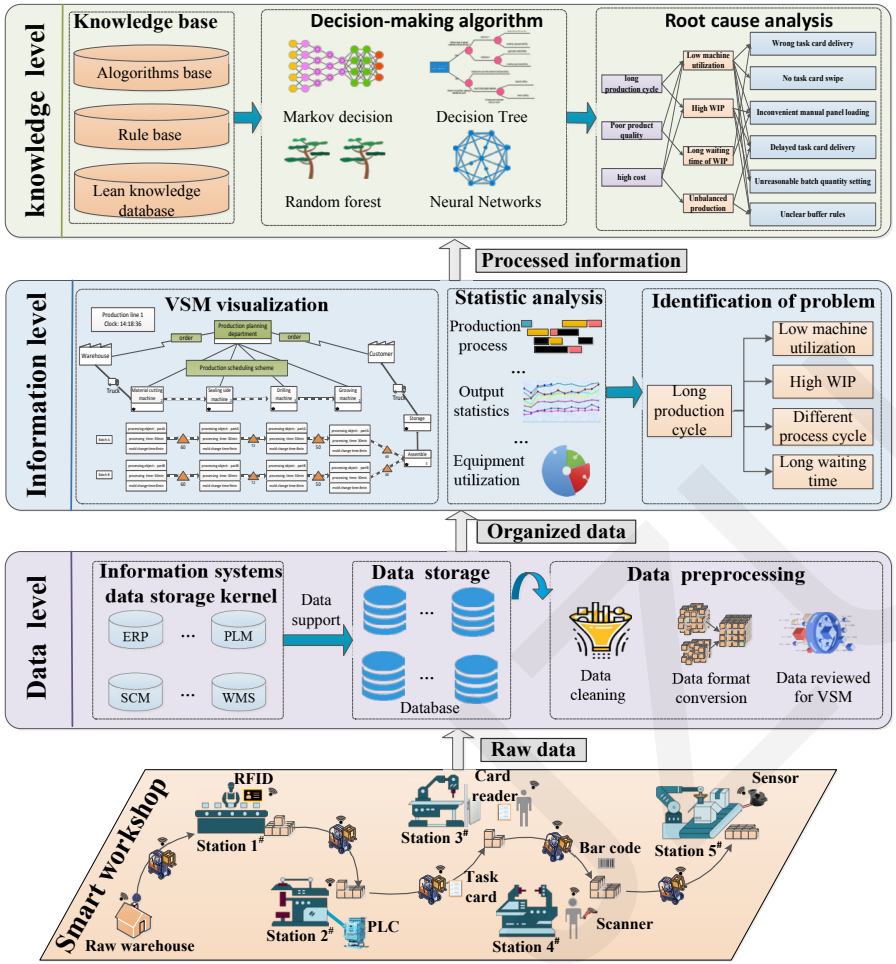


Figure 2. The proposed systematic framework of automated value stream mapping

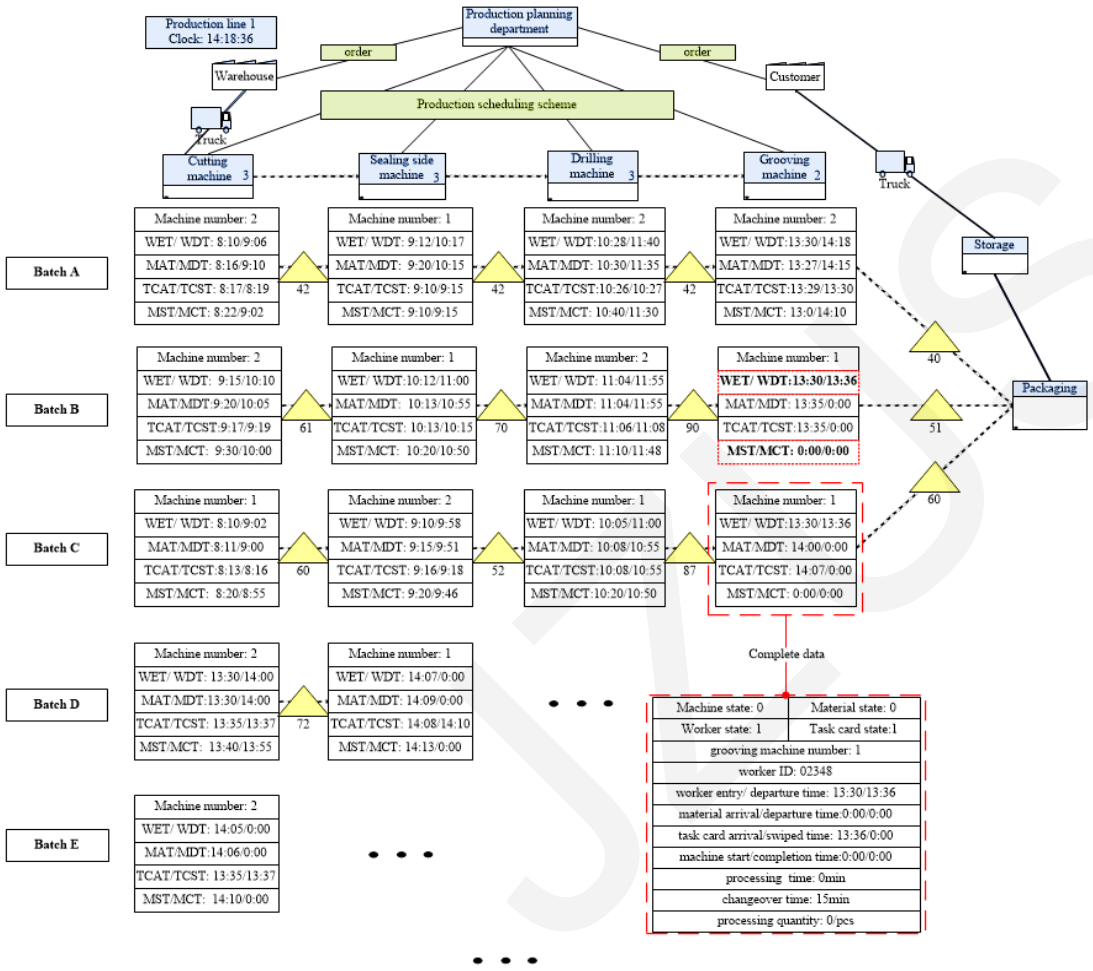
The framework follows the Data-Information-Knowledge hierarchy model

Indicates how data can be collected in a smart workshop, processed into information, and then interpreted into knowledge

It explains the automated data flow from smart workshop to knowledge level for analyzing root causes based on VSM

Highlights

A gradually generated VSM along with the parts processing is developed to represent the dynamic production process.



The data box of VSM is redesigned

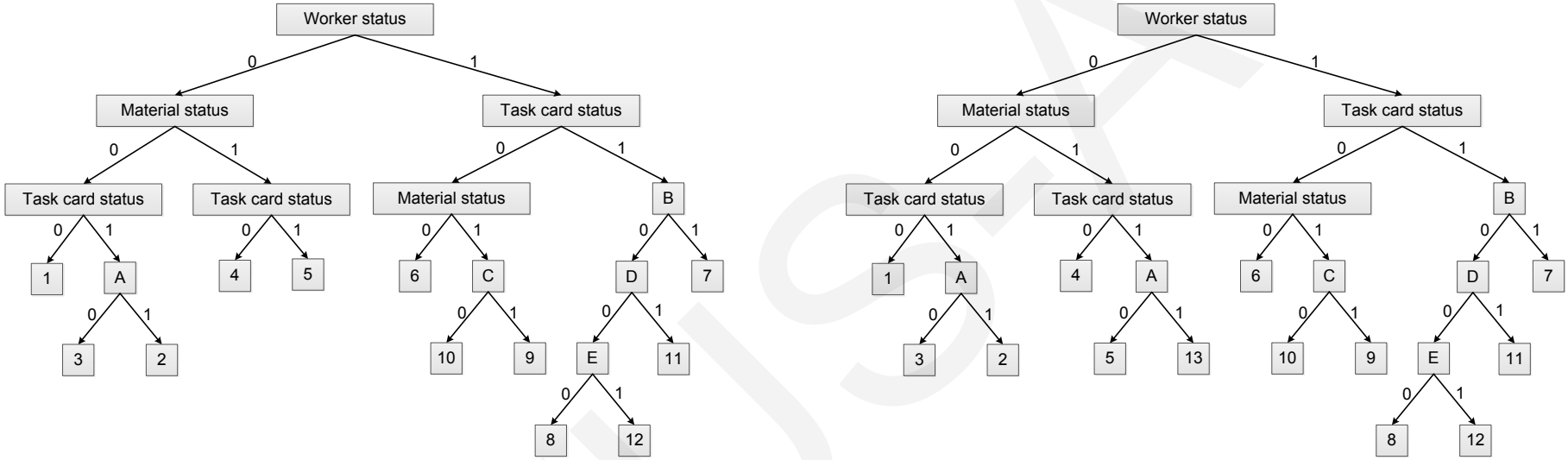
VSM can represent the status of the entire production site at a given time

Only the key information for developing the required VSM is illustrated in the data box

Figure 3. The automatically generated and visualized VSM

Highlights

Automated root cause analysis is performed to improve the accuracy and efficiency of decision-making based on decision tree making algorithm.



(a) The originally generated DT

(b) The updated DT

Figure 4 An decision tree generation and update

Automated root cause analysis was implemented in a panel-type furniture workshop of a manufacturer in Hangzhou, China

Automated root cause analysis can significantly improve decision-making efficiency by reducing on-site investigation, which is labor-intensive and experience-dependent

Conclusions

In this paper we propose a systematic framework of automated VSM to rejuvenate lean production tools in the Industry 4.0 era. An implementation case of a furniture manufacturer in China is introduced to help readers better understand the framework.

Contributions：

1. The framework proves that it is feasible to incorporate Industry 4.0 technologies to improve the efficiency of traditional VSM

2. It provides a roadmap to help enterprises integrate Industry 4.0 technologies and lean production tools to achieve a higher level of manufacturing performance and competitiveness

3. It shows that traditional VSM can make full use of production data to cater for multi-varieties and small-batch production, with timely on-site waste identification and automated root cause analysis