

Scheduling Based Decision Support System Design for Determining the Number of Setup Workers Under SMED Environment

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Abstract

In industrial manufacturing systems, high profit achievement aim considers financial performance under the use of scarce resources and limiting wastes require a systematic approach lean method. Inventory cost, idle time cost, material cost, rework cost rise with large-lot production and work pieces. Achieving economic lot requires setup activity effect. Setup activity effect consists of setup activity time. Setup activity time is production time of previous setup activity exact product to successive setup activity exact product. Manufacturing difficulties of many enterprises push them to demand lean manufacturing tools and develop new ways. Cellular manufacturing, Value stream mapping (VSM), Total productive maintenance (TPM) and Single minute exchange of dies (SMED) are vital lean manufacturing tools to separate Non-value added activities (NVA) and Value added activities (VA), and eliminate wastes. Many studies examined the first four lean manufacturing tool. In this study, scheduling of set-up tasks on SMED environment proposes to examine lead time reduction, lean production method and scheduling setup tasks of setup activity. Continuous improvement encourages setup workers and operators to involve frequent improvement. In the case of yarn processing, setup activity and setup task of machine assigned for jobs to reduce raw material and processing time waste.

Main Text

Implementing short setup activity time at manufacturing system accomplishes flexible production system and Just in time (JIT), Kanban, and SMED are lean tools to achieve short setup activity time [1, 2]. Every lot or order requires setup activity in operations. Internal setup activity is offline machine activity. SMED purposes to reduce internal activity, and accelerate production speed considering the lead time. External activities are running machine setup activity. SMED focus on simplifying, developing, and eliminating setup activities converting internal setup activity to external setup activity in time period from the 1950s to today [3]. Setup activity time is the key factor to robotics and industrial manufacturing systems to attain future technologies. Before the application of the SMED method, external setup activity from internal setup activity called non-productive setup activity. Reducing non-productive setup activity increases proficient setup workers, efficient facility layout, and machine utilization rate [4, 5]. Consequently, manufacturing facility is well-arranged and less industrial accidents occur. It merits study because added value increase efficiency of enterprise management and production control activity with SMED method. Nonetheless, there is untraced study on scheduling usage of SMED. The contradicting objectives of the enterprise prepared for the simultaneous realization of production system environment through reducing the setup time are minimizing cost, maximizing the capacity utilization rate and staying with low inventory levels.

Aims of optimizations obtain management and planning assessments. Optimization includes time-saving with minimum investment requirement. This problem holds on the aim of many departments at the industrial manufacturing system. General production costs are the direct result of manufacturing system capacity. Production operations a range of products affect capacity. Short setup times are the obligation in any industry due to the important part of production lead times [6]. Reducing the setup time

is precedence for small batch production in the enterprise. More flexible production system, small batch production and greater product variations also improve the ability to react quickly to customer orders. Demand fluctuations rarely affect production considering manufacturing capacity conditions. SMED is the method to reduce the setup times using internal and external times. This event reduces the setup time of the bottleneck workstation, decreasing inventory and improving productivity. Although SMED method permits decreasing setup activity time, heuristic algorithm, optimization and SMED connected maximum efficiency for enterprises. The research question is set-up tasks scheduled in optimization and heuristic environment or not researches articles about SMED. Literature review summarizes articles about SMED method. The examined articles have classification according to the listing of purposes, including SMED method, SMED related application and setup optimization or not comprehensively.

This research reveals to develop unique heuristic algorithms for setup task scheduling based on optimization. New methodology contributions not only for heuristic algorithms and optimization but also scheduling of SMED method. Methodology approached heuristic and optimization from a perspective of SMED method. Setup activity design includes internal setup activity and external setup activity. Thesis research differentiates current studies from external setup activity, determine setup worker and machine operator, parallel machine, divisible setup task. Setup activity constitutes set of pre-external, internal and successive external setup activity in this report. Pre-external setup activity composes requirements of the previous order or lot. Internal setup activity needs to stop machinery. Machine power takes energy to produce involving successive external activity. In example of yarn process, planned production and scheduling is applicable for this problem due to the usage of the raw material and machine parts involving spindles, bobbins, and material cops. Twisting production system enables spindles, bobbins and material cops to rod twisted yarn. All spindles take energy to power at the same time until all the raw material gets twisted. Controlling the spindle, bobbins and material cop qualities are setup activity for the successive lot. Raw material twist process is machine job. After multiple types of data show implications for system design and engineering, setup activity precedencies and formulas ease the flexibility of industrial manufacturers. Structured frameworks for evaluating setup task scheduling based on optimization and SMED methodology achieved. Parallel machine system is an ideal scenario for the chosen problem. Parallel machine has functions running on the same data in parallel. This thesis research is industrial solving methodology for enterprises in optimization environment. It concerns unsolved or low efficiency problem database. Solving methodology addresses precedence knowledge of set-up activity and precedence illustrates order among the setup activity types. Three heuristic algorithm, formulas and precedence of setup activity types to correct the methodology and model.

Figure 1 implies first heuristic algorithm to assign code numbers to setup activities according to the related job sequences on machines. Figure 2 implies second heuristic algorithm to assess time requirement for set-up activities with different number of setup workers. Third heuristic algorithm calculates the lateness time with the total number of setup workers are recorded. Minimum lateness is determined as the solution for the number of setup workers. Three of heuristic algorithm follow planning internal, pre-external, and successive external setup activity and optimum assess time, and lateness time. Setup worker and operator assignment optimize machine configuration, lean road map tools and

effective machine optimization. Standardized and simplified operation setup activities enhance optimization of layout confirmation. Shortened setup time enables reducing customer lead time, decrease processing time. New technology adoption success ratio increases. Industrial system produces minimal stock levels to every manufacturing process completed just in time for successive process. Comprehensive management and planning assessments propel SMED, scheduling and optimization throughout the research.

First heuristic algorithm focuses first machine and first job on the sequence. All jobs are examined whether or not they are completed. On the unprocessed jobs on the machines considered and pre-external, suc-external, and internal setup activities done for next job precedencies successively assigned. Then all jobs on the focused machine has job sequences read before next machine job sequences read and all setup activities assigned. After all machines setup activities are assigned, number of setup activities saved and algorithm finished. Second algorithm starts with the first setup activity, it lists setup activities to be performed. If the type of the focused setup activity is internal, total number of workers is assessed as one more than the number of setup workers, since machine operators are included to internal setup activity process.

Then setup workers and machine operators are coded sequentially. Iteration index is set to one and the algorithm lists the feasible set-up tasks with respect to the current time and prioritizes them with ascending feasibility time order (latest completion time for the predecessors of the set-up task). Similarly, available workers at the current time are determined accordingly, and sorted with respect to their release time (finishing time of the latest sorted task) is completed increasingly. The algorithm attempts to match set-up tasks with workers according to their feasibility and release time rankings in the related iteration. The sets of matched set-up tasks and workers are updated after each assignment is performed. The rank of setup tasks in related iteration is scanned with the systematic. Then, starting and completion times of assigned set-up tasks are recorded, and set of scheduled set-up tasks as well as release times of the matched workers are updated. On the condition that unscheduled set-up task(s) exist, the iteration index is increased by one and current time is updated. Then, the next iteration is executed. Otherwise, the maximum of completion times for scheduled set-up tasks is determined as the time for the related set-up activity with the focused number of set-up workers. The algorithm computes the time for the same set-up activity with the other setup worker combinations similarly. After the related set-up activity is addressed with each setup worker combination, the next set-up activity is focused. The algorithm is terminated when time requirements for all of the set-up activities with each number of set-up workers are identified.

Declarations

Declaration of interests

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The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Not applicable

Code availability

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Authors' contributions

Not applicable

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Figures

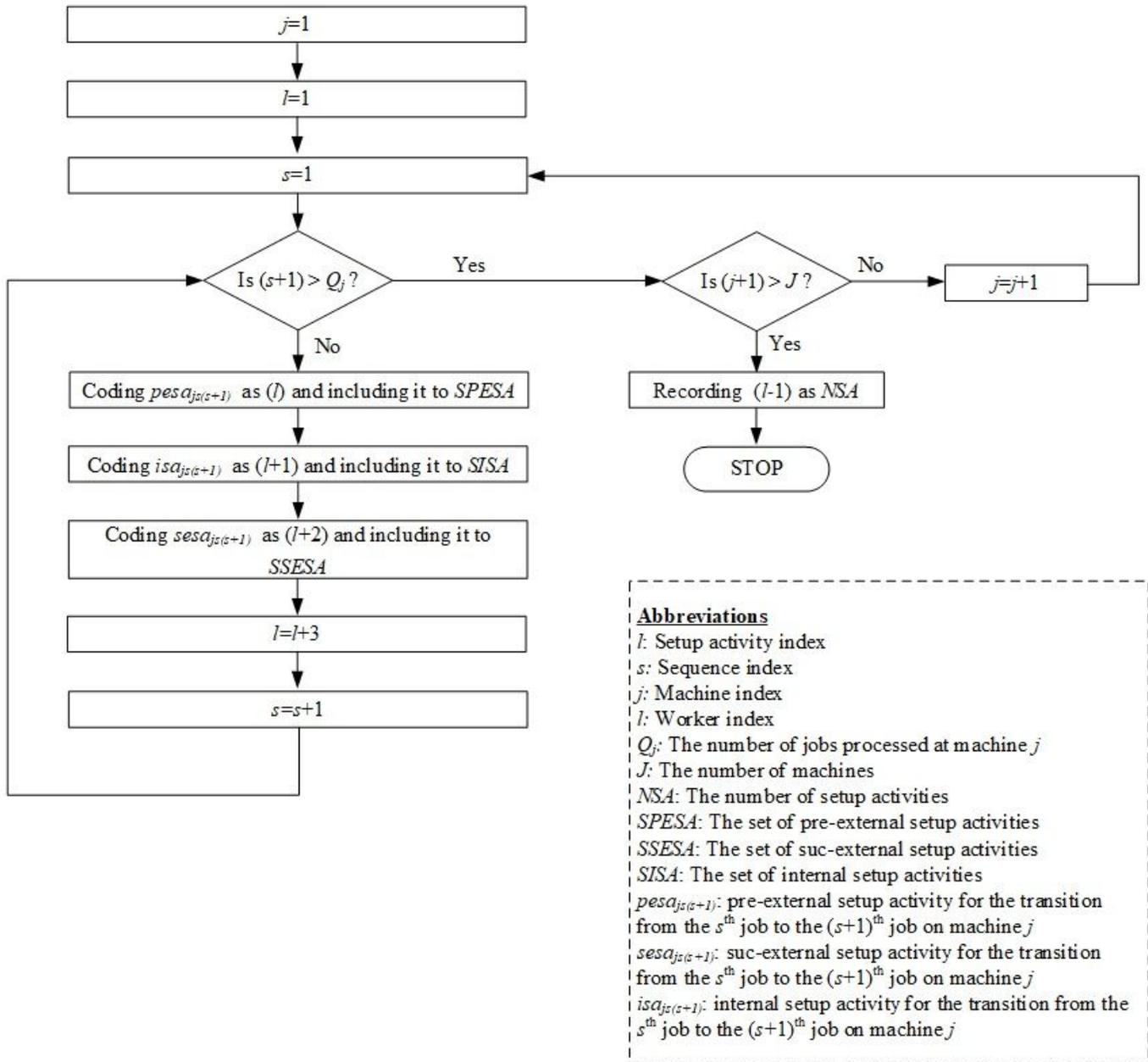


Figure 1

First heuristic algorithm.

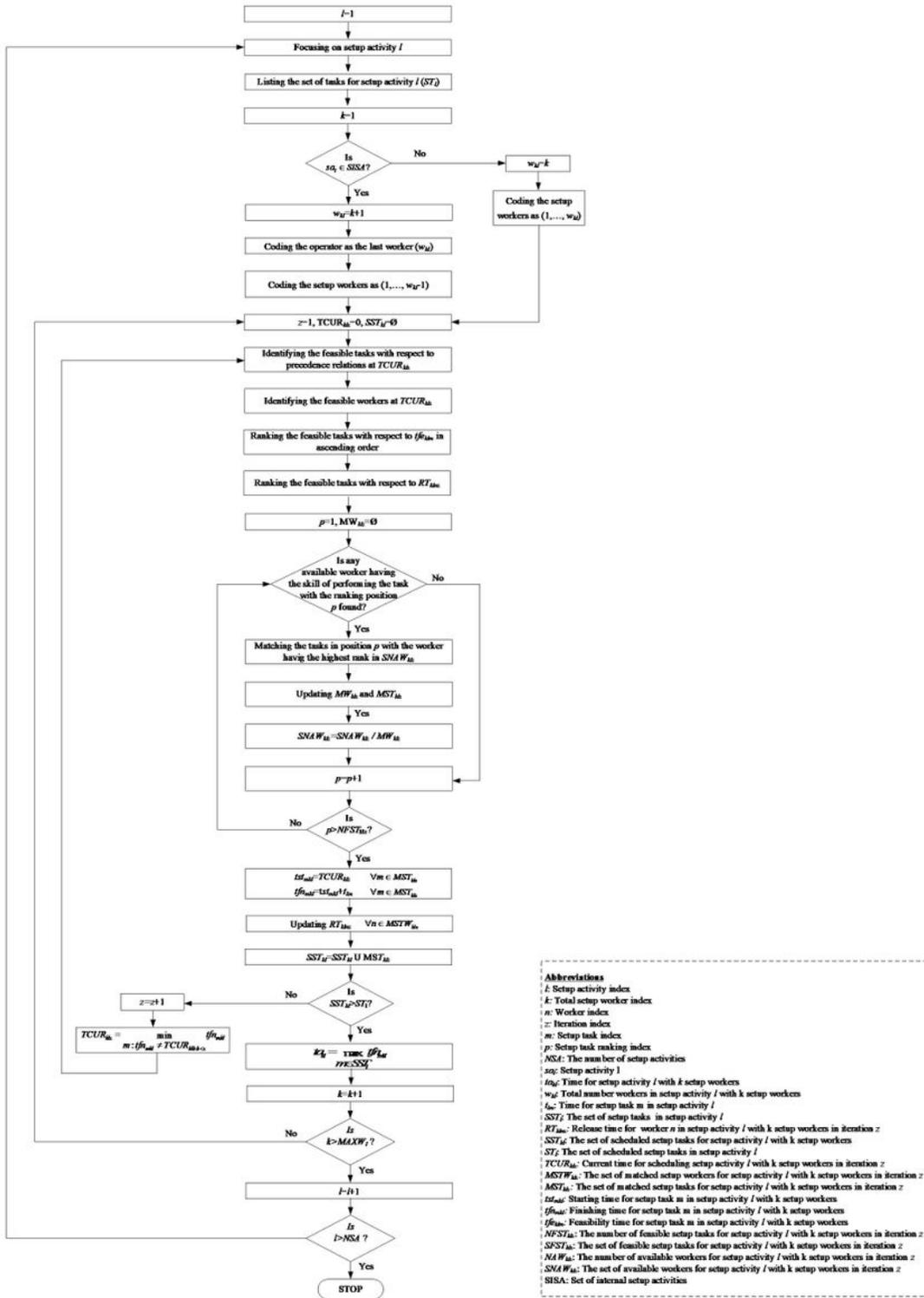


Figure 2

Second heuristic algorithm.