A Petri net model for the integration of purchasing, production and packaging using Kanban system

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ABSTRACT

A new generic deterministically timed Petri net (PN) model was developed for the integration of purchasing, production, and packaging using the Kanban system. Firstly, the individual building blocks of the model were developed which are then combined together to obtain the overall integrated PN model. This model allows the modeling of an integrated production system configuration for determining the optimal Work-In-Process (WIP), lead-time, station's utilization, and rate of production of the system. Each station can have multiple identical servers. The model is solved first by initial marking and then by optimal marking using LINGO software. The machining server circuit with the largest cycle time determines the bottleneck station, as the cycle time of this circuit merely represents the capacity of the corresponding station. Elementary circuits with cycle times greater than the cycle time of the machining server circuit are selected for optimization. These circuits result in constraints. The objective of optimization is to ensure the WIP minimum corresponds to the maximum throughput. The maximum throughput with the minimum WIP is formulated as a linear programming problem. The model can be used for designing, evaluating, and optimizing the layout of an integrated production system. This model could be extended using Fuzzy PN, Coloured PN, or Queuing PN.

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Model Petrijeve mreže za integracijo nabave, proizvodnje in pakiranja s pomočjo Kanban sistema

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POVZETEK

Razvili smo nov časovno determiniran model Petrijeve mreže (angl. Petri Net – PN) za integracijo nabave, proizvodnje in pakiranja s pomočjo Kanban sistema. Model smo zgradili postopoma prek posameznih gradnikov do celovitega integralnega modela na osnovi Petrijeve mreže. Model omogoča oblikovanje integriranega proizvodnega sistema za določanje optimalnega obsega procesnih zalog, pretočnih časov, izrabe kapacitet strojev in proizvodne učinkovitosti celotnega sistema. Vsako delovno mesto (postaja) lahko ima več identičnih strežnikov. Model smo najprej rešili z začetnim označevanjem, nato pa z optimalnim označevanjem (tj. dodeljevanjem osnovnih postavk, žetonov) s pomočjo programske opreme LINGO. Delovno mesto z najdaljšimi proizvodnimi časi je ozko grlo v proizvodnji. Cilj optimizacije je bil zagotoviti minimum procesnih zalog ob sočasni največji zmogljivosti proizvodnje, kar lahko opredelimo kot problem v okviru linearnega programiranja. Model lahko uporabimo za oblikovanje, ocenjevanje in optimiranje razmestitve opreme v proizvodnem sistemu. Razširimo ga lahko s pomočjo preostalih vrst Petrijeve mreže, npr. mehko Petrijevo mrežo (angl. Fuzzy Petri Net), obarvano Petrijevo mrežo (angl. Coloured Petri Net) in t.i. *Queuing* Petrijevo mrežo.

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