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Research Article

IQschedule: An Interactive Production Scheduling System Including Recommendations and Animations by Using IOTs for Machining Operations

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Production Scheduling, MII, Recommendation Systems, Industry 4.0.

Abstract
One of the most important ways to avoid the cost in many industries is to reduce the time taken to complete processes. Delivery time and quality are the most important criteria for customers. Successful production planning and production scheduling can help the process to be completed in a shorter time. Scheduling is an improvement and/or optimization problem that has significant implications for many industrial enterprises in terms of time, labor/equipment usage, and costs. Although experienced planners who know well the system they work on can solve this problem up to a point; it will be more logical to develop a technology that will provide the synchronization of the system, more accurate forecasts, and correct determination of priorities. Thanks to this technology, rapid synchronization of information and the ability to access the information from the desired channel at any time will streamline the process. In order to improve their processes, IQ Vizyon has produced solutions that will enable companies to create more value in a shorter time. IQV MII (Manufacturing Integration Intelligence) is one of these solutions that provide IT (Information Technologies) and OT (Operation Technologies) data with single system management. It tackles the processes of managing and monitoring production instantly at the entire factory level. It receives transiently all production information from robot, CNC or NC machine control panels, PLC, ERP (or MRP), and operators. The developed system compares the production planning processes with the actual data and presents them to the audit by making machine, project, and personnel-based reports. IQV Schedule, one of the modules of IQV MII (Manufacturing Integration Intelligence), is established on a cloud-based system with a big data infrastructure consisting of the machine and personnel data of all workstations in the production area that directly affect production and all data generated in ERP and MRP systems and to be used in the production processes. This big data collection will help to create faster solutions for crisis that may occur in production, reload works, and alter priorities. With the use of this module profitability and the number of productions per unit time increases, processes improve, energy consumption, work accident, service, maintenance, and

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personnel costs are reduced, and lastly production, deadline, and time compliance increase. This system needs users to enter and update customer importance values. Then the priority must be entered such options as FIFO, priority of the first deadline or priority of the shortest total processing (throughput) time in manufacturing. Adequate data generation will contribute to the software to make recommendations. Furthermore, users need to enter tolerance type. The maximum number of days allowed for dispatch delay and/or minimum machine utility values (%) will also be received from the user. If the results are not satisfactory, the user will be able to make the necessary changes. Data from scheduling and actual manufacture will be used for further analysis and better operations of the software. The algorithm will continue to be developed after real industrial applications. In this way, manual calculation and planning will not be required and instant monitoring will be possible. Some originalities of IQV Schedule are being able to use real-time data, working interactively, developed especially for machining and assembly operations, and a recommendation system. With the integration of MRP and ERP of IQV Schedule software, (using product tree information, inventory information, and standard production time information, in the direction of data from MRP/ERP consisted of work orders required to fulfill orders, and production orders), it will be possible to determine the order in which the works should be done by which sources, taking into account the delivery times/priority. Consequently, the developed approach will take the burden away from the employee and increase the profitability of the company.

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1. Introduction

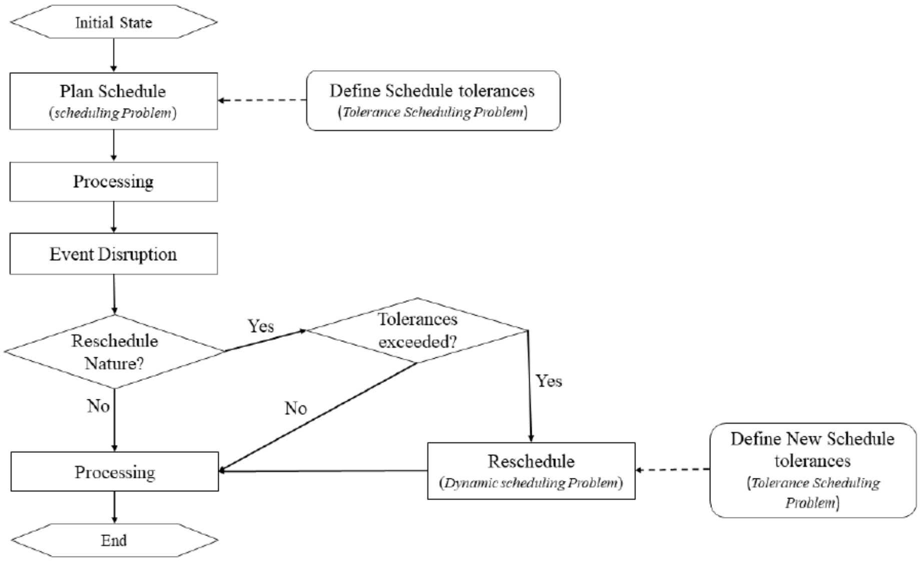
Production scheduling is one of the most important problems in a manufacturing company. Since the manufacturing systems get more complex and customer demand increase, an interactive and real time scheduling are necessary for today's production firms. The scheduling software needs also intelligent infrastructure.

2. Literature Review

One of the main aspects of these systems is production planning, especially scheduling operations on machines. (Rossit et al. 2019) They suggest a framework. It is explained in Figure 1.

Rossit and Tohmé (2018) use a concept defined in this study as the Tolerance Scheduling problem, which means identifying the range of scenarios in which a given chart remains optimal or at least acceptable in practice. Production planning and scheduling applications have made significant contributions to increasing productivity in different industrial branches. In recent years, the greater incorporation of high technology into production systems has led to the emergence of the concept of the fourth industrial revolution. One of the pillars of Industry 4.0 is the implementation of Cyber-Physical Systems (CPS), which are physical production systems that include complex computational tools. This means deploying computers that provide a real-time link between workstations and Decision Support Systems. In this environment, it is important to link scheduling to CPS. The availability of real-time information will have a significant impact in this area and it will be possible for planning to be resolved in decentralized decision processes in the future. Ye et al. (2018) proposes a knowledge-based method to plan the operation of an intelligent CNC Controller.

Figure 1. Smart scheduling (Rossit et al. 2019)



Gao et al. (2020) review energy-efficient scheduling in intelligent production systems.

Helo et al. (2019) focus a cloud based production scheduling system for sheet metal manufacturing and discusses the requirements of scheduling as a service and explain a genetic algorithm based scheduling application. Fang et al. (2019) presented parameter updating method of scheduling model to change the scheduling parameters by the dynamic events. Dynamic interaction scheduling strategy was designed to timely response to dynamic events.

Liu et al. (2018) integrated maintenance and scheduling. “The performance of the proposed methods by one case study is analyzed. The proposed methods have better performance than other methods.”

According to Ghaleb et al. (2020), the use of real-time information can significantly improve scheduling decisions. “Baseline schedules quality is essential for the quality of the realized schedules. Both event-driven and continuous rescheduling policies show similar performance.”

To determine the proper dispatching rules, a deep Q-network (DQN) is proposed by Luo (2020). To represent the production status, seven generic state features are retrieved. Six composite dispatching criteria have been developed to reduce overall delay. Deep reinforcement learning and two improvements are used to train the DQN. The DQN's efficacy and generality have been confirmed by numerical experiments.

3. The Developed System: Qschedule

IQV MII (Manufacturing Integration Intelligence) is one of these solutions that provide IT (Information Technologies) and OT (Operation Technologies) data with single system management. It tackles the processes of managing and monitoring production instantly at the entire factory level. It receives transiently all production information from robot, CNC or NC machine control panels, PLC, ERP (or MRP), and operators. The developed system compares the production planning processes with the actual data and presents them to the audit by making machine, project, and personnel-based reports.

IQV Schedule, one of the modules of IQV MII (Manufacturing Integration Intelligence), is established on a cloud-based system with a big data infrastructure consisting of the machine and personnel data of all workstations in the production area that directly affect production and all data generated in ERP and MRP systems and to be used in the production processes. This big data collection will help to create faster solutions for crisis that may occur in production, reload works, and alter priorities.

A sample screen about MII dashboard is given in Figure 2.

Figure 2. MII dashboard

With the use of this module profitability and the number of productions per unit time increases, processes improve, energy consumption, work accident, service, maintenance, and personnel costs are reduced, and lastly production, deadline, and time compliance increase. This system needs users to enter and update customer importance values. Then the priority must be entered such options as FIFO, priority of the first deadline or priority of the shortest total processing (throughput) time in manufacturing. Adequate data generation will contribute to the software to make recommendations. Furthermore, users need to enter tolerance type. The maximum number of days allowed for dispatch delay and/or minimum machine utility values (%) will also be received from the user. If the results are not satisfactory, the user will be able to make the necessary changes. Data from scheduling and actual manufacture will be used for further analysis and better operations of the software. The algorithm will continue to be developed after real industrial applications. In this way, manual calculation and planning will not be required and instant monitoring will be possible. Some originalities of IQV Schedule are being able to use real-time data, working interactively, developed especially for machining and assembly operations, and a recommendation system.

Other screen shots are in Figure 3, 4, and 5.

Figure 3. Display of unscheduled jobs and assignment of jobs to machines with drag-and-drop method

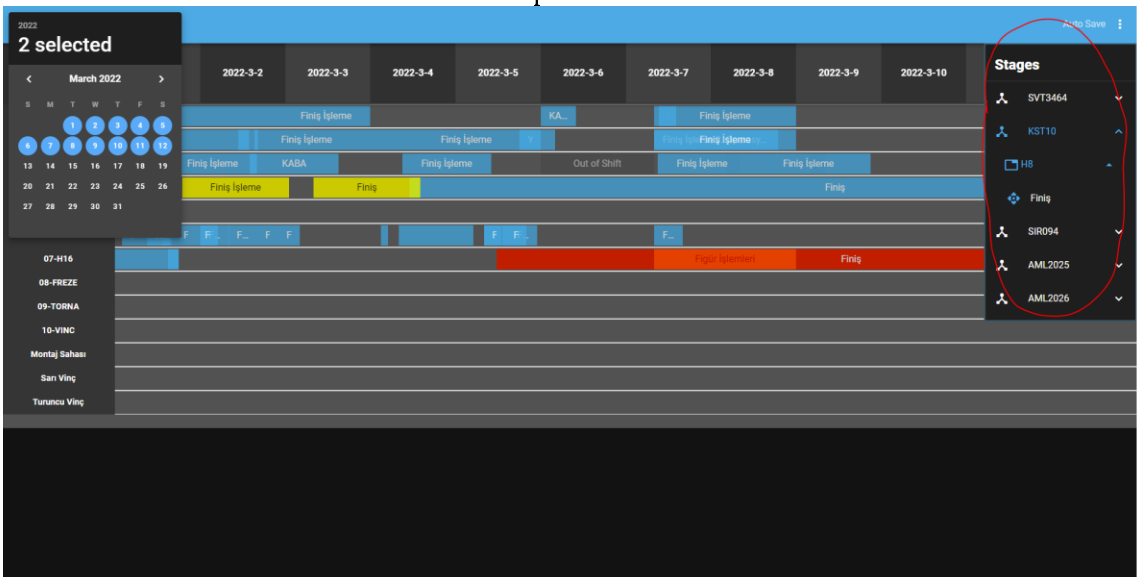


Figure 4. The delays in the deadlines of the planned operations are colored and the users are warned.

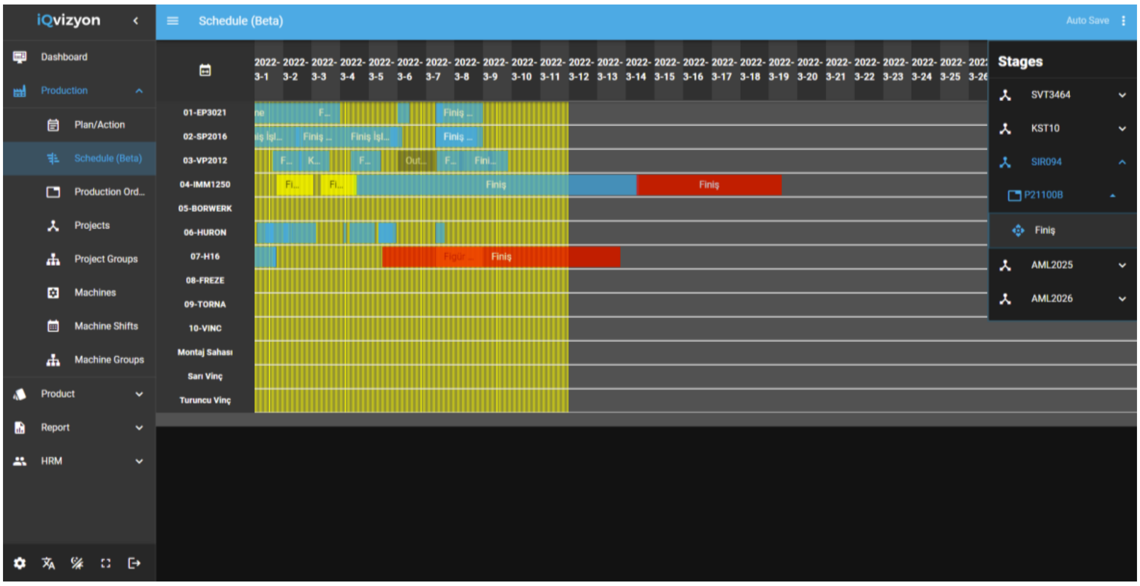
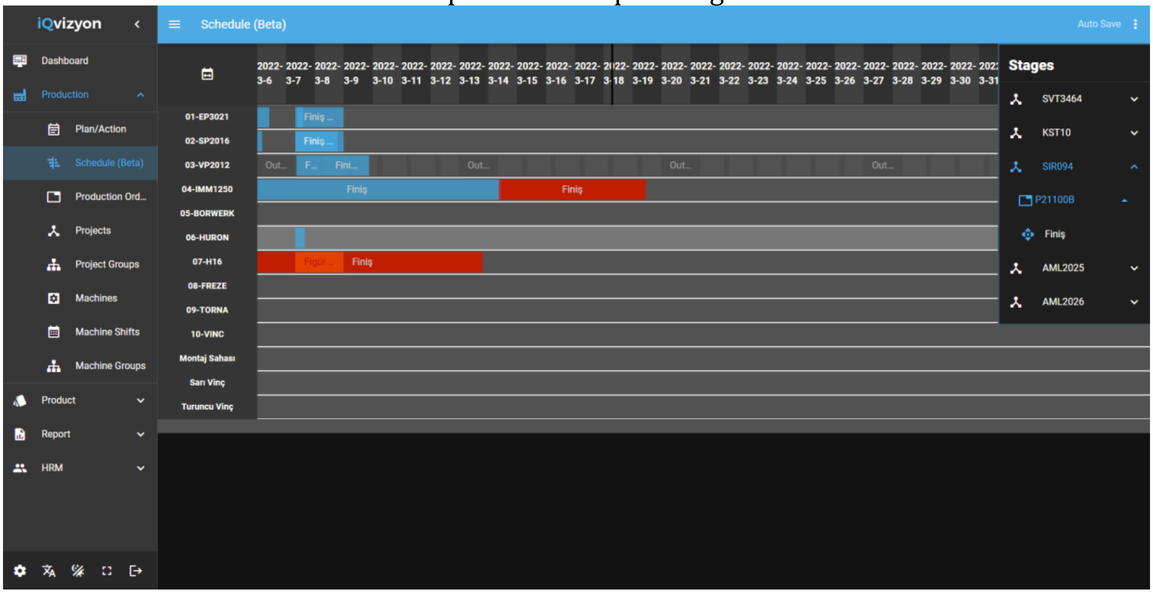


Figure 5. Overtime entries of the machines can be made, so that "out of office" hours can be prevented in planning.



IQV Schedule software integrates MRP and ERP (using product tree information, inventory information, and standard production time information, in the direction of data from MRP/ERP consisted of work orders required to fulfill orders, and production orders). It will be possible to determine the order in which the works should be done by which sources, taking into account the delivery times/priority. Consequently, the developed approach will take the burden away from the employee and increase the profitability of the company.

6. Conclusion

Our study shows that production scheduling is feasible in a dynamic and real time production environment. The system is considered for machining operations, especially CNC machines and assembly operations. It is possible to add some recommendations such as “The worker X is very fast for setup operations when working on machine Y” etc.

As further study, a real case study can be applied and the findings and results can be analyzed.

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