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A NEW INPUT-OUTPUT CONTROL ORDER RELEASE MECHANISM: HOW WORKLOAD CONTROL IMPROVES MANUFACTURING OPERATIONS IN A JOB SHOP*

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Abstract

Make-to-order companies, such as job shops, have been extensively studied. Some of those studies emphasise the importance of the workload control in order to improve manufacturing operations. In this paper a multiple decision-making scheme, with the purpose of planning and controlling operations and getting better delivery and workload related performance measures, as well as one order release decision rule are proposed. The decision-making scheme includes four main decisions: (i) accept or reject an in-coming order; (ii) define the order's due date; (iii) release the accepted jobs; and (iv) dispatch the jobs at the station level. Extensive simulation experiments were performed to compare the proposed rule with the benchmark mechanisms, as well as with rules presented in previous studies. They led to the conclusion that considering the four decisions simultaneously can improve the job shop measures of performance, and that the proposed release rule is the best in almost all instances.

JEL Code: M11 Production Management

Key words: job shop, input-output control, workload control, order release.

I. INTRODUCTION

In make-to-order production environments the concept of workload and input-output control is of crucial importance to improve manufacturing operations. The characteristics of a job shop highlight the need for a system that controls the jobs entering and the work-in-process, leading to an improvement of operational measures, like percentage of tardy jobs, mean tardiness, mean absolute deviation, mean flow time, mean queue time, or total lead time.

The decision-making scheme includes four main decisions. At each decision stage, benchmark rules are considered (e.g., total acceptance, immediate release or first come-first served dispatching), as well as some rules proposed in earlier studies (e.g., acceptance based on total accepted workload, backward infinite loading, modified infinite loading, total work content, number of operations, or earliest due date). A new decision rule is considered at the release phase, based on the workload and the input-output control concepts, as it tries to control the amount of work in the shop floor. As far as we know, it is the first time that these four decisions are considered and analysed simultaneously. Another innovative issue is that the releasing mechanism takes into consideration not only the input control but also the output control and the capacity adjustment problem.

The central idea of the proposed job release mechanism, labelled PIOC (Proposed Input-Output Control), is to control the input, in terms of jobs released to the shop floor, and the output, in terms of shop production capacity, at the same time. The PIOC release mechanism includes information about the jobs, the shop floor and the shop capacity, increasing capacity if necessary and controlling the workload on the shop floor by appropriately releasing jobs.

The simulation experiments were performed to compare the proposed rule with the benchmark rules, as well as with other rules presented in previous studies. They led to the conclusion that considering the four decisions simultaneously can improve the job shop delivery and workload related performance measures, and that the four decisions are not independent of one another. The simulation results also showed that PIOC is the best release rule in almost all instances (e.g., leading to a decrease of around 40% in the average time in the shop floor).

This paper has three objectives: firstly, to present a design for planning and controlling the four-main decision-making problems, secondly, to propose a new decision rules (for releasing) and thirdly, to explore and understand the relationships among these four control decisions.

The paper is structured as follows: in next section we present the multiple decision-making design. The research methodology (simulation model, experimental factors, performance measures and data collection) is outlined after. In the last section the results of the main experiment are discussed and, then, the conclusion summarizes the study reported here and presents important observations regarding the results.

II. THE MULTIPLE DECISION-MAKING DESIGN

In a broad sense, the production control system for a job shop can be viewed as consisting of four stages. Associated with each stage is a control decision: 1) accept or reject an order, 2) define the order's due date, 3) release or not an order to the shop floor and 4) define the sequence in which the orders on the shop floor are processed. Figure 1 shows, schematically, these four decisions, the points where they are made and the relationships among them.

Order arrivals follow a Poisson process with a mean of 1 arrival per hour. Besides the widespread use of the Poisson distribution, there is some theoretical evidence that it provides a good approximation to the arrival process (Albin 1982). The routing for each order and the processing time at each station are generated at this stage. The routing is purely random: the number of operations follows a discrete uniform probability between one and six machines. The order has an equal probability of having its first operation on any of the six machines, and of going to the others, until having reached the number of operations defined. After the definition of the job characteristics, it is placed in a pending (for acceptation) orders file. Now, the company has to make its first decision: accept or reject the order, taking into account information such as price, due date, product specifications, quality levels, shop capacity, and so on.

The literature on order acceptance/rejection is quite recent. The common assumption of the early published literature is that all orders received by the shop will be accepted, regardless of shop conditions or order characteristics. (Philipoom and Fry 1992), in their study, relaxed this assumption such that in times of high shop congestion, it may be better to reject an order, allowing the costumer to look for another supplier, than to accept the order and deliver it late. The question is that when the shop floor is highly congested, accepting more orders may put at risk the ability of the shop to fulfil the other orders' due date. (Wester et al. 1992; Wouters 1997; Nandi and Rogers 2003; Ebben et al. 2005), are some of the papers where the possibility of acceptation/rejection is analysed.

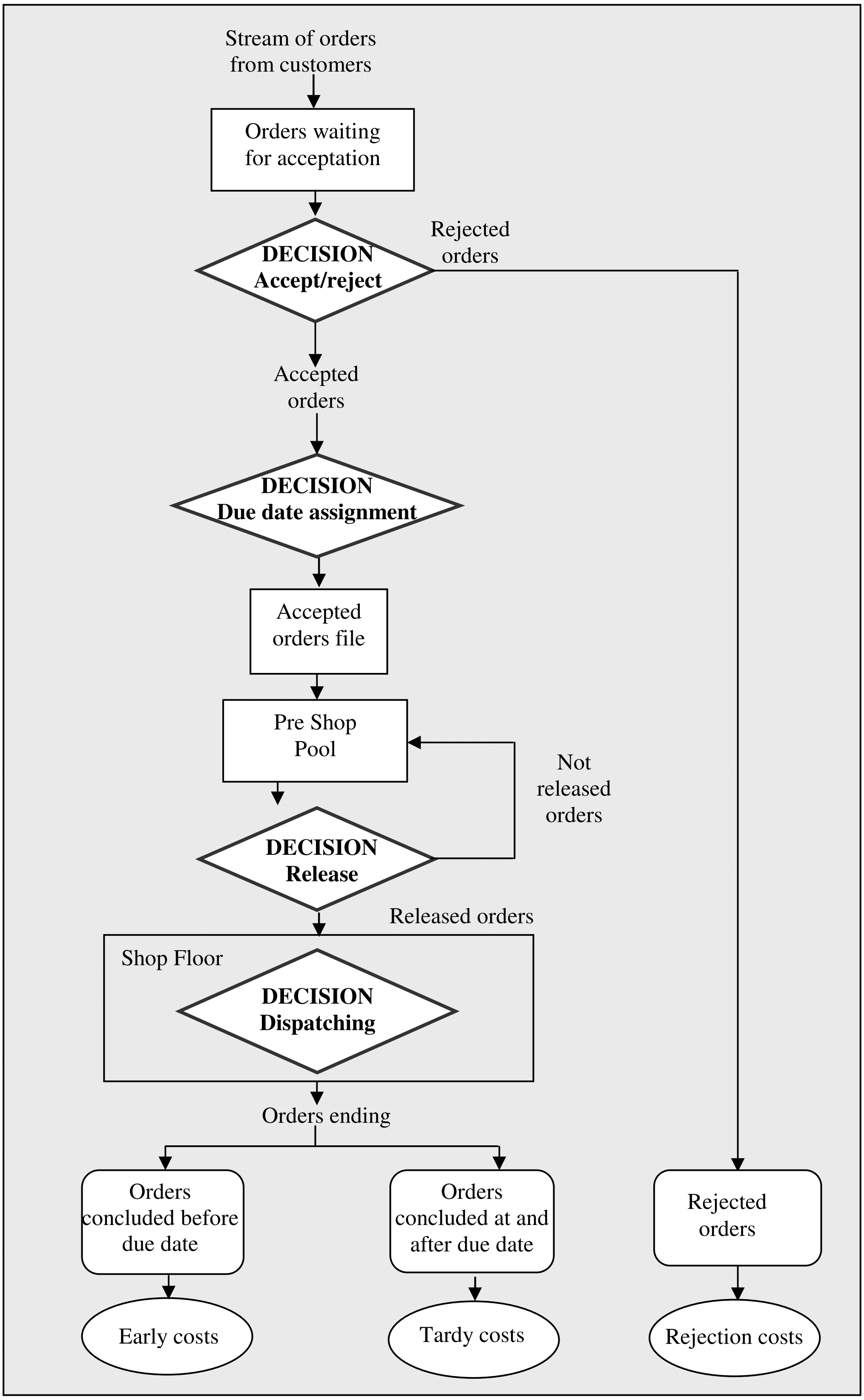


Figure 1 – Multiple Decision-Making Scheme

The decision about the due date assignment is made after the acceptance decision. There are several ways to determine the due date; in general, due date rules include information about the order (e.g. number of operations, processing time in each machine, orders arrival date) and the shop floor (workload in each machine, queues dimension, etc.). A lot of research has been made around this issue, alone or combined with other decision rules (e.g. Bertrand 1983a, 1983b; Ragatz and Mabert 1984; Bobrowski and Park 1989; Ahmed and Fisher 1992; Tsai et al. 1997; Sabuncuoglu and Karapinar 2000).

After an order has been accepted, it is placed in an "accepted orders file". In our study it corresponds to the pre shop pool file, since we assume that materials are available when the job is accepted. The order (or job) release decision establishes when a release must occur and what job should be selected. The releasing mechanism is used to determine which of the jobs eligible for release actually will be sent to the shop floor. The releasing function controls the level of work in process inventory. It usually takes into consideration some jobs features (like expected total processing time, due date, number of operations, the routing, etc.) or/and the shop floor congestion degree (shop total workload, workload per machine, etc.). Information about the shop capacity is hardly ever considered, notwithstanding the fact that it represents a major element of the input/output control. The proposed job release mechanism includes this information. Several order release mechanisms are suggested and studied in the literature. An extensive list can be consulted in (Bergamaschi et al. 1997). More recently, (Bertrand and Van de Wakker 2002) investigate the effects of a number of essentially different work order release policies. Moreover, emphasis is being made on integrating the order release mechanism in the planning system.

Once a job is released to the shop floor, its progress is controlled by the selected dispatching rule. If more than one operation is waiting to be processed in a machine, then it is necessary to decide which is to be processed in the first place. When all processing has been completed on the order, the job is placed in the finished-goods inventory until its delivery (due) date. Early deliveries are forbidden.

Accept or reject decision

The first decision to be made is when a customer places an order. In our study, two accept/reject rules are simulated: total acceptance (TA) and acceptance based on the actual and future workload (AFW). The TA acceptance mechanism is used as a benchmark. The

AFW rule was proposed by (Nandi 2000). If the arriving order will not cause the workload limit to be exceeded, it is accepted, otherwise, it is rejected. The sole purpose of the rule is to keep the total shop load under control rather than allowing it to grow limitlessly.

Due date definition decision

The decision about the due date assignment is made immediately after the acceptance decision. In our study we will simulate only one rule because by varying the planning factor associated we can convert one rule into another. The total work content (TWK) rule defines the due date, adding a certain amount, representative of the time that the job will need to be completed, to the order's arrival date. This is done in the following way:

$$DD_i = AD_i + k_{TWK} * P_i \quad (1)$$

where: DD_i: due date of job i,

AD_i: job i arrival date

P_i: processing time of job i

k_{TWK}: planning factor

The planning factor will allow us to analyse the interaction between the four main decisions when due dates are defined in a tighter (k_{TWK} = 4.6) or looser (k_{TWK} = 77.7) way.

Order release decision

After being accepted, orders may be released to the shop floor at any time. The order release mechanism determines when and what the job (in the pre shop pool) should be released. Several rules have been studied and proposed in the literature, from simple (like the immediate release) to sophisticated ones (e.g. backward infinite loading). In our study, four order release rules are simulated: immediate release (IMR), backward infinite loading (BIL), modified infinite loading (MIL) and the proposed input output control (PIOC). The IMR release rule is used as a benchmark (as soon as an order in accepted it is released to the shop floor). The BIL mechanism consists on deducting the expected job flow time from the due date. The MIL rule was proposed by (Ragatz and Mabert 1988). It is similar to the BIL rule (because it ignores the shop capacity) but has more information to predict the job flow time (it includes a planning factor about the actual work on shop). MIL determines the job release date as follows:

$$RD_i = DD_i - k_{1MIL} * n_i - k_{2MIL} * Q_i \qquad (2)$$

where: RD_i: release date of job i,

DD_i: due date of job i,

n_i: number of operations of job i

Q_i: number of jobs in queue on job i routing

k_{1MIL}, k_{2MIL}: planning factors

The planning factors are constants of the job' number of operations and the number of jobs in queue on job routing. Their functions are to transform the job' number of operations in (a good prediction of) the job flow time, and the number of jobs in queue in the waiting (queue) time, respectively.

The input output control (PIOC) rule developed in this research includes information about the orders (due date, processing time, number of operations and routing), about the shop floor state (workload in all machines) and information related with the shop capacity.

There is a job release whenever one of the following events occurs:

- the latest release date (LRD) of an order is reached, or
- the workload (corresponding to the jobs in the queue) of any station goes below a pre-defined lower limit.

The latest release date is computed in the following way:

$$LRD_i = DD_i - P_i - k_{CIOP} * n_i \tag{3}$$

where: LRD_i: job i latest release date,

DD_i: due date of job i,

P_i: processing time of job i

n_i: number of operations of job i

k_{CIOP}: planning factor

The planning factor is a constant of the job' number of operations. Its function is to transform the job' number of operations in (a good prediction of) the job queue time in any machine.

In the first case, the job that has that date is released. If several jobs have the same LRD, the job that has the earliest due date is selected; if there is still a tie, the job with the largest processing time is chosen. In the second trigger mechanism, the job that has its first operation in the station whose queue is under the lower limit is released; if more than one job are tied, the job with the closest LRD is selected; if a tie still exists, the job with the earliest due date is chosen. The output control is performed by setting an upper limit on the workload of the shop and by computing the workload corresponding to the jobs in the pre-shop pool. If the computed workload is above the upper limit then a decision to increase short-term capacity is made (like hiring temporary workers, working a second shift or overtime).

The general code (algorithm) behind the proposed order release rule is as follows:

```
Next (Count, accepted orders)
Next (Assign, acceptance date, entity type)
Next (Assign, release part = machines in the routing*processing time
                                              + kCIOP * machines to visit)
If release part – INT (release part) == 0 Then release date == due date – release part
Else release date == due date - INT (release part) + 1
End If
While ((day < release date) And (workload in queue  >= x hours)
        Next (Delay, wait for release date))
Loop
Next (Assign, shop floor entering day == actual day,
              output == output – processing time)
Next (Search a queue, minor release date and minor workload in queue)
Next (Remove, the order with the smaller release date or the order with its 1st operation in
               the machine with the smaller queue)
Next (Record, pre shop pool time )
```

Dispatching decision

Once a job is released to the shop floor, its progress through the shop is controlled by the dispatching rule in use. The dispatching rules considered in this study are the first come, first served (FCFS) and the earliest due date (EDD). The FCFS does not consider job or shop information in setting priorities, and was selected as a benchmark. EDD rule uses the job's due date information to compute its priority.

III. RESEARCH METHODOLOGY

Simulation model

The simulation model was developed using the software Arena 7.1. (Kelton et al. 2004). The characteristics of the hypothetical job shop are identical to those used by (Melnyk and Ragatz

1989). That is, the shop consists of six work centres operating 40 hours per week. Each work centre contains a single machine and can process only one job at a time. No preemptions are allowed. Job routings are random, with no return visits. The number of operations per order is uniformly (discrete) distributed between one and six. Order arrivals follow a Poisson process with a mean of 1 arrival per hour. The processing time distribution for all six machines is identical: exponential with a mean of 1.5 hours. These characteristics result in a steady state utilization of 87.5% for each machine.

Experimental factors

In testing the acceptance/rejection rule and the releasing mechanism, it is important to assess whether their performance is affected by other factors in the planning system, such as the due date and the dispatching rules being used. Therefore, we used a full 2 x 4 x 4 x 2 design of experiment. The two accept/reject rules, described above, were simulated in combination with four levels of due date tightness, the four order release rules presented and the two priority dispatching rules just displayed.

To vary due date tightness, the value of the planning factor (k_{TWK}) in the due date formula described above was set at 4.6, 12.9, 38 and 77.7.

Performance measures

In order to assess the impact of the rules developed in this research on manufacturing performance, specific performance criteria must be selected (from the numerous presented in literature and used in firms) bringing in mind the goal of this study. Nine measures of shop performance were recorded in the simulation. These measures were broken down in two categories:

(i) Due date related performance measures, which are an indicator of costumer satisfaction and deliverability: mean tardiness, percent tardy, proportion of rejected orders and mean absolute deviation.

(ii) Workload related performance measures, which are used to evaluate the impact of the load observed on the shop floor: mean wait time in the pre shop pool, mean wait time in final products inventory, mean queue time in the shop floor, mean total time in the system and machine utilization.

We decided on two kinds of measures in order to evaluate the rules in several perspectives.

Data collection

During simulation runs, data are collected with reference to the steady state of the system. In order to remove the effects of job shop start-up, several runs of the simulation model were considered. Performance criteria and utilization levels reached steady state after approximately 4 000 working (simulated) hours. To be cautious, all statistics were set to zero and restarted after a warm-up period of 10 000 simulated hours. Statistics were, then, collected for 90 000 hours. Ten replications were performed for each set of experimental conditions.

IV. RESULTS OF THE MAIN EXPERIMENT

The results of the simulation runs are summarized in Tables 1-9, with Tables 1-4 containing the results for the due date related performance measures and Tables 5-9 including the results for the workload related performance measures. Each exhibit breaks down observations by accept/reject rule, due date tightness, release procedure and dispatch mechanism for the mean values of the ten completed runs.

Table 1 – Mean Tardiness (days)

A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	3.8	3.7	3.6	3.5	1.9	1.1	1.1	1.1
	BIL	3.7	3.6	3.3	3.2	2.1	1.8	2.0	2.1
	MIL	3.9	4.2	3.8	3.3	2.2	1.9	2.1	2.5
	PIOC	2.5	2.8	2.5	2.3	1.7	12	2.1	3.4
AFW	IMR	1.4	1.4	1.4	1.4	1.1	1.1	1.1	1.1
	BIL	1.4	1.1	0.8	0.1	1.0	1.0	0.2	0.0
	MIL	1.3	1.0	0.4	0.1	1.0	1.0	0.3	0.0
	PIOC	1.4	1.4	1.4	1.5	1.1	1.1	1.0	2.0

Table 1 presents the results for the mean tardiness. We can see that, in almost all combinations, the number of days of delay decreases when the due date becomes less tight. Moreover, the employment of the EDD dispatching rule allows a deep cut in the value of mean tardiness, whatever the accept/reject or order release rule in use. The utilization of a mechanism that limits the acceptance drives to a decrease in the mean tardiness. In Table 2 we can observe that an enlargement of the due date (increase in k_{TWK}), the existence of a reject possibility and the employment of the EDD rule induce a decrease in the proportion of orders delivered later than the due date.

Table 2 – Percent Tardy

A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	0.52	0.26	0.10	0.05	0.14	0.01	0.000	0.00
	BIL	0.52	0.27	0.13	0.08	0.20	0.03	0.02	0.01
	MIL	0.52	0.30	0.15	0.09	0.24	0.05	0.03	0.03
	PIOC	0.36	0.13	0.05	0.03	0.02	0.00	0.00	0.01
AFW	IMR	0.17	0.06	0.02	0.01	0.01	0.00	0.00	0.00
	BIL	0.14	0.01	0.00	0.00	0.01	0.00	0.00	0.00
	MIL	0.12	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	PIOC	0.17	0.06	0.02	0.01	0.01	0.00	0.00	0.00

As expected, the presence of an accept/reject rule does have a significant effect on the percentage of rejected orders (see Table 3). However, this fact can be minimized if we combine its use with the PIOC order release mechanism.

Table 3 – Proportion of Rejected Orders

A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BIL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MIL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PIOC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AFW	IMR	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	BIL	0.06	0.22	0.47	0.60	0.07	0.22	0.47	0.60
	MIL	0.07	0.25	0.49	0.61	0.08	0.25	0.49	0.61
	PIOC	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.05

Another important measure is the mean absolute deviation. It is important because it determines how far deliver dates are from the promised due dates. From Table 4, we can notice that when due dates are tightly defined, there is no such difference among the values obtained from the order release rules. Nevertheless, if due dates are defined far in time, the rules BIL and MIL become better than the PIOC.

Table 4 – Mean Absolute Deviation (days)

A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	2.8	6.2	21.5	47.2	1.3	6.6	23.0	49.0
	BIL	2.7	3.7	5.0	5.5	1.3	3.3	4.9	5.5
	MIL	2.8	3.6	4.5	4.9	1.4	2.8	4.1	4.7
	PIOC	2.1	6.4	21.6	46.5	1.7	6.4	20.8	43.5
AFW	IMR	1.8	6.3	20.8	43.9	1.9	6.6	21.1	44.2
	BIL	1.7	4.2	5.7	6.3	1.8	4.2	5.7	6.3
	MIL	1.7	3.7	4.9	5.4	1.8	3.8	4.9	5.4
	PIOC	1.8	6.3	20.8	43.6	1.9	6.6	21.1	43.9

Table 5 – Mean Wait Time in the Pre Shop Pool

A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BIL	0.11	2.59	16.6	41.8	0.11	2.60	16.6	41.78
	MIL	0.14	2.74	16.9	42.2	0.17	2.98	17.3	42.51
	PIOC	0.16	0.39	0.25	0.26	0.02	0.00	0.02	0.09
AFW	IMR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BIL	0.05	0.91	3.87	8.09	0.05	0.91	3.88	8.10
	MIL	0.10	1.13	4.33	8.73	0.10	1.13	4.34	8.73
	PIOC	0.00	0.01	0.01	0.06	0.00	0.00	0.00	0.02

The workload measure "mean wait time in pre shop pool" is affected by the introduction of the accept/reject decision. Once the acceptance limits are based on the total workload (due to orders accepted but not yet finished), when the quantity of work corresponding to the orders waiting in pre shop pool reach that limit, the new incoming orders are rejected (or placed for negotiation). In Table 5 we observe that when we use the PIOC rule, the time that orders spend in pre shop pool is very low. This is explained by the definition of the PIOC mechanism: the release can be initialised by the occurrence of one of two events.

Table 6 – Mean Wait Time in Final Products Inventory

A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	2.8	8.3	24.8	50.9	1.8	7.1	23.7	49.7
	BIL	2.5	4.5	5.6	6.0	1.7	3.7	5.2	5.7
	MIL	2.4	4.0	5.1	5.4	1.7	3.2	4.4	4.9
	PIOC	2.9	8.0	23.8	48.8	2.1	6.9	21.4	44.1
AFW	IMR	2.7	7.5	22.1	45.3	2.3	7.1	21.6	11.8
	BIL	2.5	4.5	5.8	6.4	2.2	4.5	5.8	6.4
	MIL	2.4	4.0	5.0	5.5	2.1	4.0	5.0	5.5
	PIOC	2.7	7.5	22.0	44.8	2.3	7.1	21.6	44.5

Table 7 – Mean Queue Time in the Shop Floor

A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	3.93	3.93	3.93	3.93	2.04	1.74	1.72	1.70
	BIL	3.87	3.93	3.90	3.92	2.29	2.54	3.17	3.39
	MIL	4.03	4.44	4.37	4.14	2.42	2.67	3.38	3.59
	PIOC	2.29	1.84	2.08	2.11	0.95	0.95	0.93	0.90
AFW	IMR	1.25	1.25	1.25	1.25	0.77	0.76	0.77	0.77
	BIL	1.11	0.31	0.06	0.03	0.71	0.25	0.06	0.02
	MIL	1.01	0.25	0.05	0.02	0.65	0.21	0.05	0.02
	PIOC	1.25	1.24	1.23	1.17	0.77	0.76	0.76	0.75

The time period that, on average, the order spends in the final products inventory waiting to be delivered corresponds to the mean earliness (Table 6). When the EDD rule is in use, the mean earliness decreases, independently of the other decision rules applied. The total time in the system and the mean time in queue can be reduced if the PIOC rule is used, almost in all combinations (Tables 7 and 8). The machine utilization level is affected by the existence of the rejection decision. But, if the acceptance rule is combined with the PIOC, the decrease is smoothed (see Table 9).

Table 8 – Mean Total Time in the System

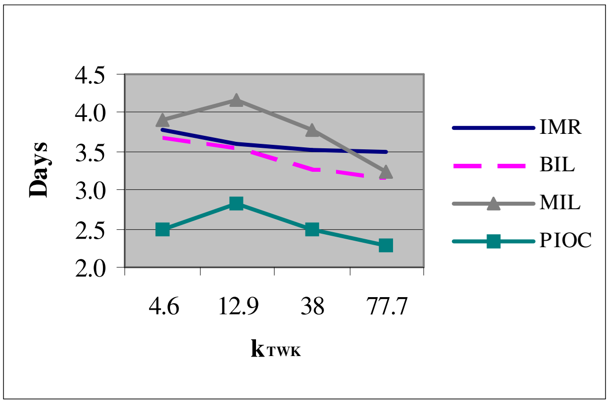
A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	7.4	12.9	29.4	55.4	4.5	9.5	26.0	52.0
	BIL	7.2	11.6	26.9	52.5	4.8	9.5	25.7	51.6
	MIL	7.2	11.9	27.1	52.5	4.9	9.5	25.8	51.6
	PIOC	6.0	10.9	26.7	51.8	3.7	8.4	22.9	45.7
AFW	IMR	4.5	9.3	24.0	47.1	3.6	8.4	23.0	13.1
	BIL	4.3	6.2	10.0	14.7	3.5	6.1	10.0	14.7
	MIL	4.1	5.8	9.7	14.4	3.5	5.7	9.7	14.4
	PIOC	4.5	9.3	23.9	46.6	3.6	8.4	23.0	45.8

Table 9 – Machine Utilization (percentage)

A/R	O/R	Dispatching rules							
		FCFS				EDD			
	D/D	4.6	12.9	38	77.7	4.6	12.9	38	77.7
AT	IMR	0.87	0.87	0.87	0.87	0.87	0.88	0.88	0.88
	BIL	0.88	0.87	0.87	0.87	0.87	0.88	0.88	0.87
	MIL	0.87	0.88	0.88	0.88	0.87	0.87	0.88	0.87
	PIOC	0.85	0.83	0.84	0.84	0.77	0.77	0.77	0.77
AFW	IMR	0.74	0.74	0.74	0.74	0.73	0.73	0.73	0.73
	BIL	0.71	0.43	0.18	0.10	0.70	0.43	0.18	0.10
	MIL	0.69	0.39	0.16	0.09	0.68	0.39	0.16	0.09
	PIOC	0.74	0.74	0.74	0.73	0.73	0.73	0.73	0.73

Performance evaluation of the PIOC mechanism

The mechanism developed in this study, PIOC, does have a better performance in the majority of the measures, excepting the MAD, when due dates are not tightly defined. However, the situation of due date tightness is much closer to reality than the definition of larger promised dates. The implementation of the PIOC rule has a significant effect on the performance of the production system. It allows a significant improvement in several performance measures. The most visible ones are the measures 'mean tardiness' (Figure 2) and consequently percent tardy and the 'mean queue time in the shop floor' (Figure 3).



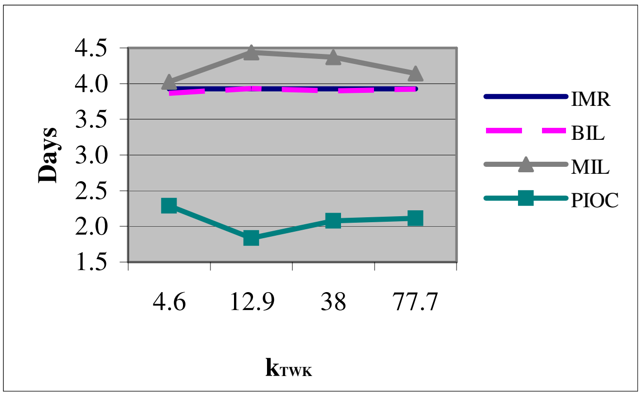


Figure 2 – Mean Tardiness

Fig. 3 – Mean Queue Time in the Shop Floor

V. CONCLUSION

The main goal of this research was to introduce a new release method as a way of controlling the workload of the job shop and to finish the orders as close as possible to the due-dates. Moreover, a multiple decision-making scheme was proposed with the aim of planning and controlling operations, and improving delivery and workload related performance measures.

The interactions among the four groups of decisions (accept or reject orders, due-date setting, order release, and dispatching) and its effects on the measures of performance of the shop (mean tardiness, mean flow time, capacity utilization, etc.) were analyzed and the performance of the proposed order release mechanism (PIOC) was compared, using simulation, with the main rules presented in the literature. From this analysis, it can be concluded that the proposed rule leads to a significant improvement of most operational indicators.

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