HEURISTIC SCHEDULING IN A NIGERIA FURNITURE SHOP

by

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Abstract
This paper presents a case study carried out in a furniture shop located in Benin, Bendel State of Nigeria.
Its products range from writing tables and desks to dining and sitting room sets. These are produced against orders. Currently, orders are dispatched using the First-come First-served sequencing rule; otherwise, known as the First in First-out rule (FIFO).
The objective or this study is to evaluate the performances of three well known heuristic sequencing pule; shortest processing time rule (SPT), longest processing time rule (LPT), and monetary value of completed order rule (MO); and possibly ascertain whether any of these rules offers a better schedule than the FIFO schedule currently used by the shop. This comparison is carried out on the basis of the combined objective of minimizing the expected mean now time of orders and the expected weekly idling time of work centres. The results obtained indicate that at least two schedules, LPT and MO, performed better than FIFO. The results are, however, system specific and therefore do not apply for all job shops.

1. Introduction

A lot of research has been conducted in the area of heuristic scheduling Job Shop situations. The furniture shop is a typical Job Shop, because products are manufactured against orders. Prominent among the studies published in this area are Jackson [1]. Arrumugam and Ramani [2]. Rochette and Sadowski [3] and Gere [4]. Two fundamental themes have been established from a review of these papers:

(i) No dispatching rule is superior to the others for all measures of performance;

(ii) The dispatching rule based on the "monetary value" of completed orders (MO), has not been properly investigated.

1.1 The Actual System

The actual system is a furniture shop managed as a private enterprise. It is located in Benin, Bendel Stale of Nigeria. Its products, manufactured against orders, include sitting room and dining· room furniture sets desks and chairs, king size beds, office furniture equipment etc .

The Shop has thirteen processing centres and a total technical staff strength of sixty seven. Orders are received by the sales department between the hours of 7.30 a.m. and 3.30 p.m. in the afternoon. The Sales Manager in consultation with the Workshop Supervisor determines the delivery dates and fixes the monetary values of completed orders. An order is released to the shop after ensuring that the materials required to process that order are available, and subsequently a Job Card is opened. As orders move through the thirteen processing centres, queues are formed, and scheduling is executed using sequencing decision rules, otherwise, called dispatching rules. The job flow diagram is schematically presented in figure 1. Not every order needs processing in all work centres. If a Job does not require shaping then the processing time of this Job in Work Centre 3 is zero.

1.2 Sample Data Collection

Sample data on the arrival pattern of orders; the monetary values of orders and the total processing time of each job in all work centres were obtained by observing the shop in operation over a three month period.

2. The Simulation Model

The sample data obtained were considered inadequate, thus the decision to simulate the production activities of the shop had to be made.

This was done using the Monte Carlo technique after building model of the actual system.

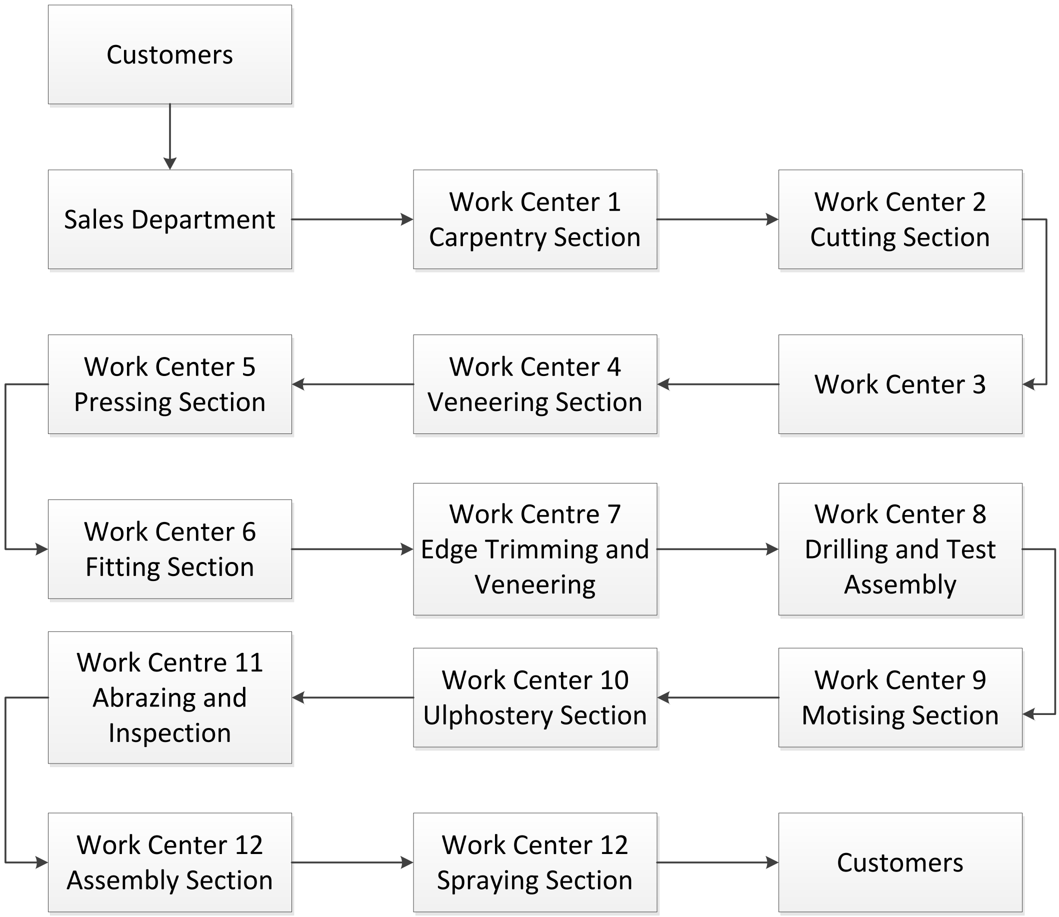

Fig. 1: Flow diagram of the actual system

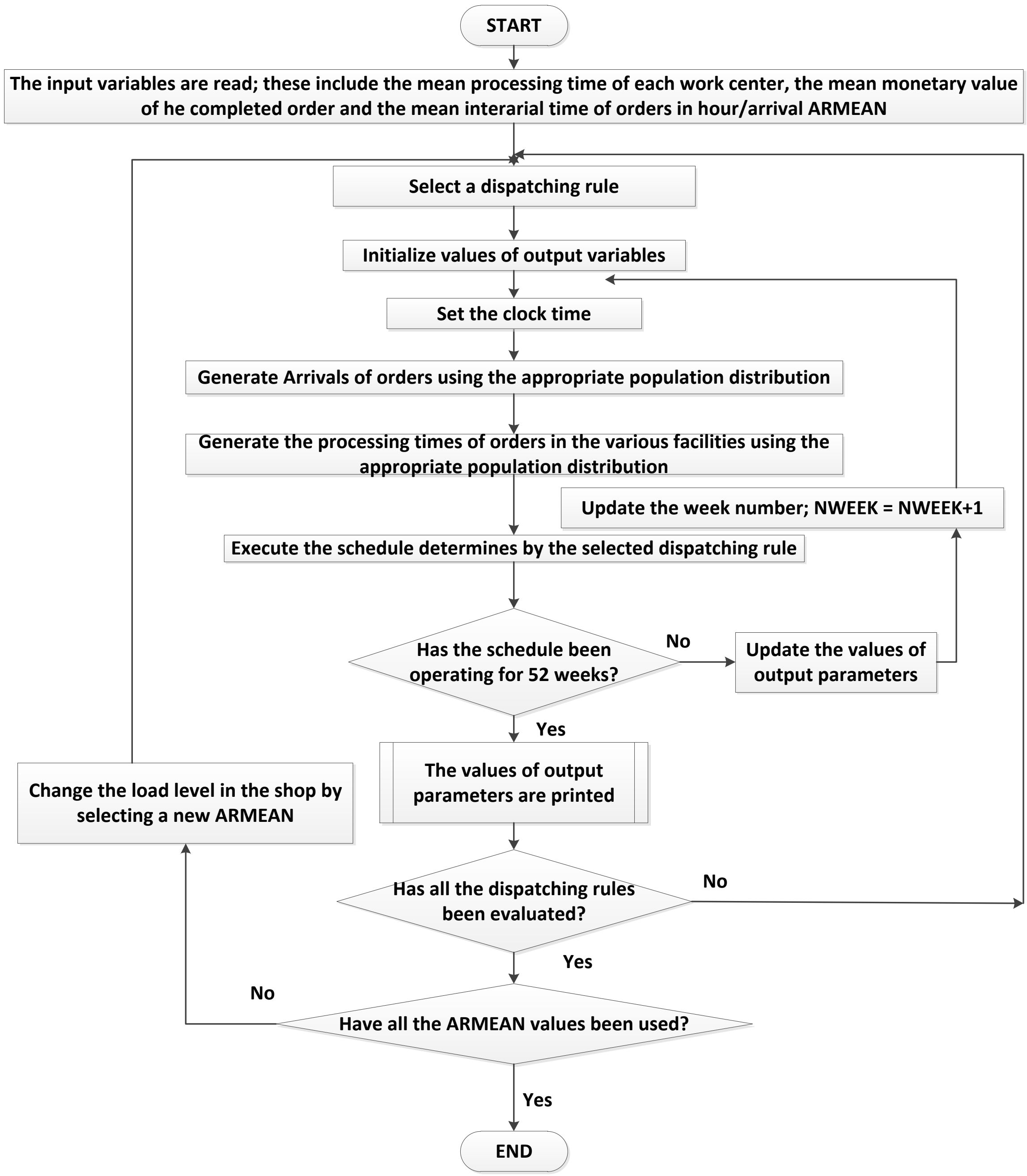

Fig. 2: System flow chart for the major segment of the simulation experiment

The sample data collected were subjected to Kolgomorov-Smirnov statistical tests and were found to fit populations described by known empirical probability distributions.

The arrival pattern of orders was poisson with a mean of ten (10) orders per month which translates to an arrival every sixteen (16) hours of work. This is taken in this study as the normal load on the shop. The monetaty values of completed orders and the processing time of each order fitted the exponential distribution.

2.1 Model Development

2.1.1 Assumptions of The Model

1. There are no retrograde movements between successive work centres
2. No reject or rework of components occurs at any work centre
3. The transit time of an order from one work centre to another is considered negligible especially when compared to the total processing time of that order.
4. On the basis of results obtained from the Kolgomorov-Smirnov tests, the arrival pattern of orders is considered a poison process; the monetary value of the completed order, and the processing time of each order are considered to have exponentially distributed populations.
5. The number of orders to be processed in a given week is based on what is left of orders collected the week before. Thus orders are not processed as soon as they arrive but rather join the queue already formed.
6. This model does not explicitly take into consideration the breakdown of processing facilities.
7. All rush jobs are scheduled differently.
8. The system is started empty and idle and all runs are started on empty and idle conditions as Conway [5] suggested.
9. Following the poison arrival pattern of orders, the inter-arrival time (i.e. the time between two successive arrivals), must be exponentially distributed.
10. Operators skills are assumed to be wert above average.

2.2 System Flow Chart

Figure 2 presents the major segment of the system flow chart for the simulation experiment. The simulation experiment was conducted on a main-frame computer of 396 Kilo Bytes Memory.

The work load on the Furniture shop is varied changing the time between two successive arrivals, otherwise called the inter-arrival time, ARMEAN. The range of ARMEAN chosen lies between a value of 10 hours per arrival i.e. an, order arrivals every ten (10) working hours, to a value of 28 hours per arrival with a step-size of 6 hours. The normal lord on the shop as observed udder the three month period is represented by an ARMEAN value of 16 hours per arrival.

The statistics of the first few runs were deleted in order to eliminate the transient the unsteady effect of simulation that are always present especially in experiments where random number are used.

Simulation results produced under different pseudo-random conditions were subjected to an F-test and the output did not show significant differences between treatments.

3. Results and Analysis

A summary of the simulation results is presented on Table 1.

3.1 Analysis of the Results

3.1.1. Variation of the mean flow time of orders, MINF with the load level of the shop

This is shown in figure 3. MINF decreased as the load level of the shop is lowered for the four schedules evaluated. This trend should be expected because the fewer the number of orders, the less the time spent in processing them.

It is desirable to minimise the mean flow tune for batch of orders in order to improve upon the delivery performance of the shop. Thus, the schedule that has the minimum values of MINF at the various load levels, is considered the best performer.

A close look at figure 3 would reveal that the SPT schedule is the best, followed by the MO, FIFO and LPT schedules in that order. Thus, the LPT schedule is the worst performer. At the various load levels, the differences in performance between the schedules are significant.

3.1.2 Variation of the Idling time of processing centres AV with the load level or the shop.

This has been shown in figure 4. As expected, AV increases as the load level of the shop decreases for the four schedules tested. Naturally, the fewer the number of orders, the more idle the processing facilities.

It is desirable to minimize the idling time of processing facilities, especially in a Job shop like the furniture shop, where expensive machinery and equipment had been installed. Therefore, the schedule that minimizes AV at the various load levels is considered the best performer. It can be easily observed that the LPT schedule offers the best in this regard, while the SYT schedule is the work performer. The MO and FIFO schedules are average performers. The difference in performance between the SPT schedule and the LPT schedule is very significant.

Table 1 Summary of Simulation Results

ARMEAN =10 hours/arrival	Mean Flow time of orders (Hours) MINF	Idling time of processing centres (hours) AV
FIFO	137.77	1.54
SPT	1.9.14	16.07
LPT	166.92	7.52
MO	123.83	12.79
ARMEAN =16 hours/arrival		
FIFO	76.45	11.30
SPT	68.39	15.90
LPT	108.14	7.95
MO	74.43	12.14
ARMEAN = 22 hours/arrival		
FIFO	73.08	13.38
SPT	50.92	18.73
LPT	81.01	11.03
MO	59.12	11.78
ARMEAN =28 hours/arrival		
FIFO	48.95	14.44
SPT	47.41	20.89
LPT	63.53	11.20
MO	47.49	14.99

3.2. The Weighted Factor Method

One question that must be addressed by this study is whether any of the other three heuristics offers a better schedule than the FIFO schedule which is currently being used by the furniture Shop. Since this comparison had to be conducted on the basis of the combined objective of minimizing both MINF and AV, resort had to be made to a weighted factor method. This method attaches equal weight to both measures of performance. It involves the allocation of points to the four rules under evaluation. A minimum weight of 50 points could be allocated to the schedule that has the most desired value of either MINF or AV of the various load levels.

To calculate the scores of the fours rules under ARMEAN of 10 hours per arrival proceed by looking for the Schedule with the most desired value of MINF and AV in Table 1. The SPT schedule has the most desired value of MINF (109.14 hours) and is therefore awarded the maximum weight of 50 points. The LPT schedule that has the least desired value, (166.92 hours) is allocated (109.14/166.92)X 50 = 32.69 points. For the AV measure of performance, the LPT schedule that has the least desired value (752 hours) and is therefore given the maximum allocation of 50 points; whereas the SPT schedule which has the least desired value 16.07 hours) gets *(7.52/16.07)* x 50 = 23.40 points. Table 2 presents the results of the weighted factor method for ARMEAN value of 10 hours per arrival.

The results of the weighted factor method indicate that the LPT and MO schedules are better than the FIFO schedule. The SPT schedule took the rear as the worst performer. It is worthy of note that the difference in performance between the LPT schedule and the FIFO schedule is significant. The same assertion could be made for the MO schedule. The difference in performance between the MO schedule and the LPT schedule is insignificant.

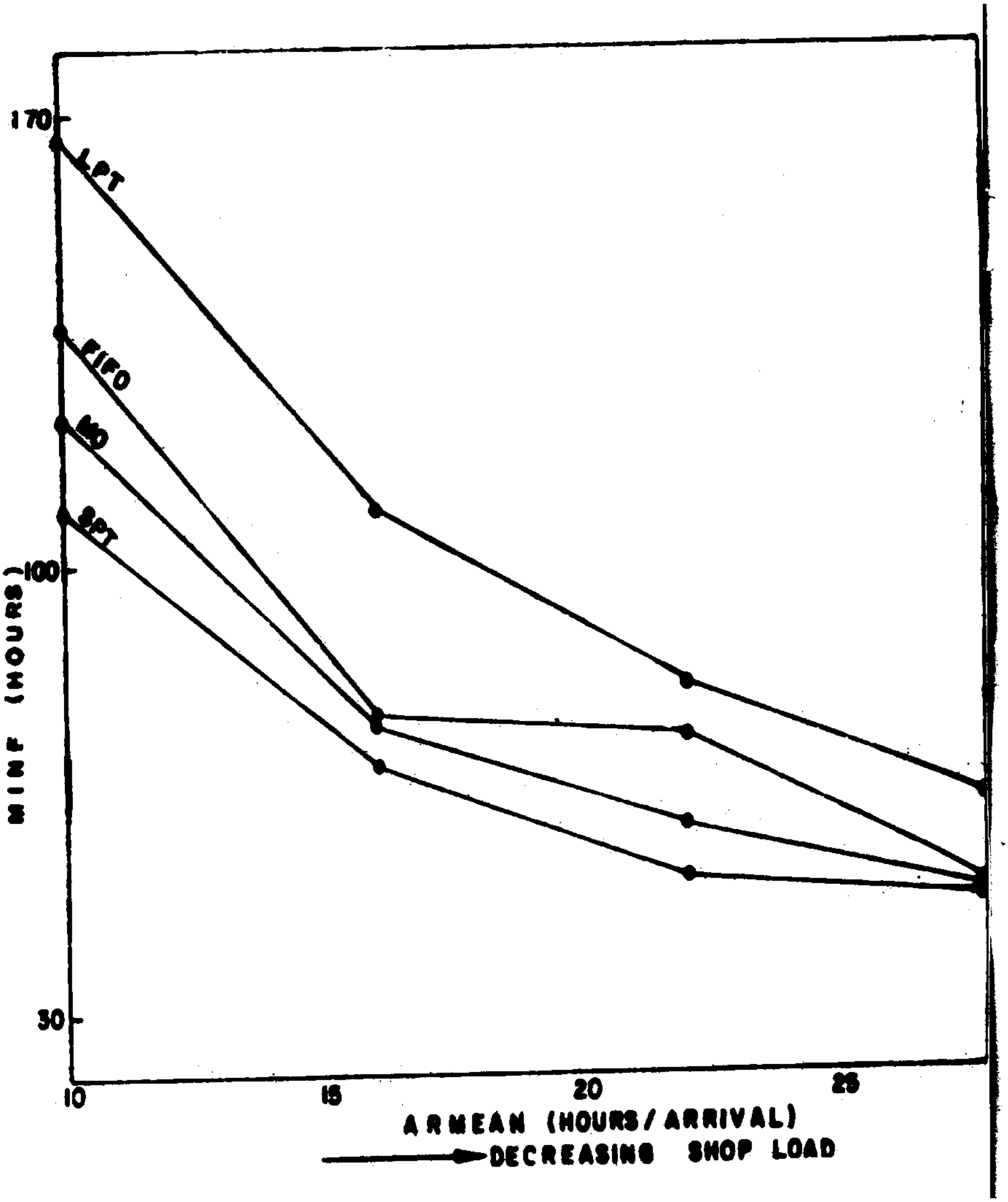

Figure 3: Variation of MINF with decreasing shop load for the four rules

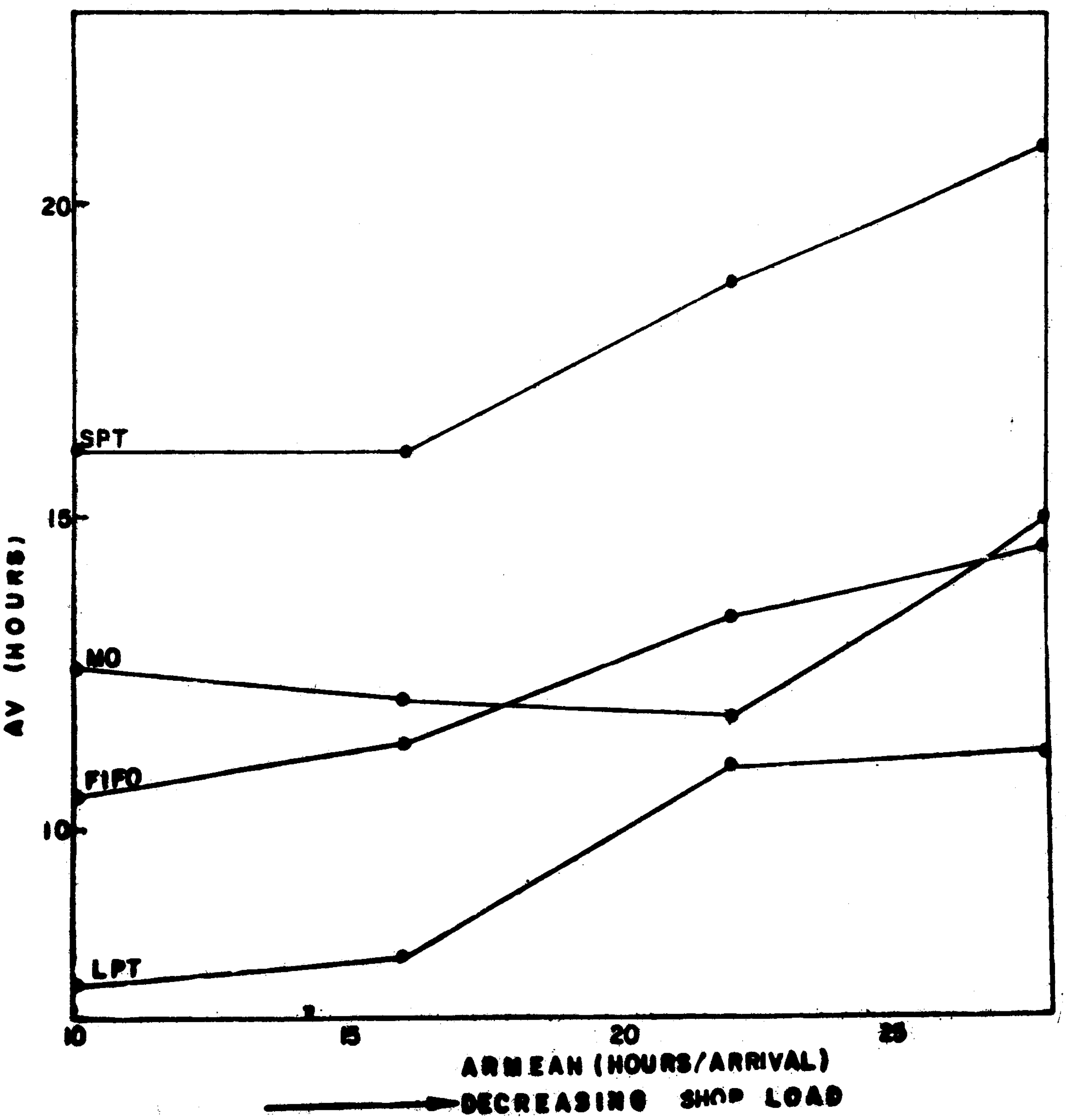

Figure 4: Variation of AV with decreasing shop load for the flour rules

Table 2: Results of the Weighted Factor Method for Armean of 10 hours per arrival

ARMEAN = 10 HOURS/ARRIVAL				
OUTPUT PARAMETERS	SCORES FOR THE FOUR SCHEDULES			
	FIFO	SET	LPT	MO
MINF	39.61	50.00	32.69	44.06
AV	35.69	23.40	50.00	29.40

Table 3: Results of the Weighted Factor Method for all Load Levels.

ARMEAN = 10 hours/arrival output parameters	SCORES FOR THE FOUR SCHEDULES			
	FIFO	SET	LPT	MO
MINF	39.61	50.00	32.69	44.06
AV	35.69	23.40	50.00	29.40
ARMEAN = 16 hours/arrival				
MINF	44.71	50.00	31.61	45.93
AV	34.90	25.00	50.00	32.74
ARMEAN = 22 hours/arrival				
MINF	34.84	50.00	31.43	83.06
AV	41.22	29.44	50.00	46.82
ARMEAN = 16 hours/arrival				
MINF	48.43	50.00	37.31	49.92
AV	38.78	26.81	50.00	37.36
Total Scores	318.16 304.65 333.04 329.29			

4. Conclusions.

From the results obtained and the analysis that followed, the following conclusions can be drawn:

1. The mean flow time of orders in hours MINF, decreases as the load level of the Furniture Shop is lowered, for the four schedules evaluated.
2. The idling time of work centres in hours AV, increases as the number of enders grows fewer, for the four schedules evaluated.
3. The LPT schedule is the best performer on the single measure of performance, AV.
4. The SPT schedule performed best on the single measure of performance, MINF.,
5. A weighted factor method that attaches the same weight to both measures of performance, produced a best performer in the LPT schedule.
6. At least two schedules, LPT and MO, performed better on both measures of performance, than the FIFO scheduled currently used by the furniture Shop.
7. The model developed, had high logical and statistical validity because, the F-test analysis of simulation outputs indicated that for different pseudo-random conditions, the output did not show any significant differences between treatments.

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