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PRODUCTION SCHEDULING IN A GARMENTS MANUFACTURING COMPANY: A CASE STUDY

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ABSTRACT
Scheduling is a major element in the value-addition chain of a production system. Optimization in schedule generation process can considerably cut short the lead-time, which may play an important role in on-time delivery of goods, specially, when penalty is associated with late delivery. Garments production has the major characteristic of penalty associated with late deliveries. Sometimes, the whole lot may be rejected because of lateness, which means very low-price sale of the lot in local market. Thus, scheduling may play an important role in development of competitiveness of the garments industry in Bangladesh. But, existing scheduling rules with associated penalty are highly complex. Simulation with several priority rules and Branch and Bound algorithm, with heuristics of Chang and Su, and Adjacent Pairwise Interchange algorithm, with certain assumptions through simplification of the problem, are some possible solutions to this end. This research study shows such an application of scheduling techniques, in order to find out an optimal schedule, in a local garments company. Objectives scheduling were minimization of lateness and tardiness.

Keywords : Scheduling, Simulation, Priority rules, Heuristic.

1. INTRODUCTION

Garments have been the major export item for Bangladesh for the last several years. But the main characteristics of international business in this area are its tough competition among several low-cost countries, such as China, India, Vietnam, Sri Lanka, etc. Apart from this, globalization opened up another avenue for a search of other tools for getting upper edge over others. Logically, the main focus for such a search will be concentrated around the optimization of supply chain system.

In the context of Bangladesh, there are plenty of avenues left for improvising several critical points in the whole supply chain network, right from raw materials supply from foreign countries, which traditionally Bangladesh do not produce, through a logistical network systems inside the country, then through the value-addition activities inside the garments factory, and then finally through export. A very high degree of uncertainty prevails in the whole sum of activities. If value-addition activities are taken into account at the very macro level, then one of the most important findings from a comprehensive study at several local garments factories is lack of application of appropriate scheduling rules.

From the study, it has been found that the companies apply a mix of two strategies: First, they try to apply Earliest Due Date (EDD) priority rule, and then they some times apply “Privileged or Priority Customer” concept, which is basically not a rule. But, scheduling in this manner is not the best choice in a garments production company, because of associated penalty with late deliveries. Application of advanced scheduling rules may perform much better under this circumstance.

A point to note that garments manufacturing is typically a job shop type manufacturing system, where orders arrive with a certain due date, and associated penalty clause in the contract. In some cases, penalty is charged based on number of days late, whereas in other severe cases, it is charged for lateness irrespective of duration.

2. COMPANY PROFILE AND PRODUCTION CHARACTERISTICS

Lunar Outwear Ltd., located in Mirpur Section-1, a Semi-industrial and residential area, is a prominent manufacturer of woven type products, such as shirts, pants (office trousers), and sports trousers. The company exports the products against the orders of customers, mainly from the European Union and USA.

Fabrics used in production are imported if synthetic garments are to be produced, whereas it is procured locally in case of cotton products. Demands of accessories, such as zippers, buttons, etc. are fulfilled from local manufacturers, such as YKK, HHH, etc.

Garments manufacturing generally involves three types of production processes, namely, cutting, sewing and finishing. Thus, though there are only three main stages of operations, the workstations are parallel, with reworks done on faulty products found through supervision after each stage of operation. In order to avoid complexity in scheduling, especially situations like np-hardness, reworks are not considered here in this study.

Number of orders, along with designs, range from 10 to 12 in a period of one month. Typically, manufacturing lead-time of an order is around one month on an average. Thus, as per characteristics of accumulated job arrival and their scheduling, it can be easily assumed that the orders arrive simultaneously and are ready for scheduling.

3. SCHEDULING ALGORITHM AND PERFORMANCE MEASURE

While, several customers submit production orders with different specifications, as is the case of garments manufacturing, complete shop routings of many customer-oriented jobs create a complex job shop type production environment. This needs simplification in scheduling rule having logical assumptions, and execution of a suitable heuristic [1, 2, 3], in order to generate a schedule in a feasible time period. For a large number of orders, as found in garments companies, vast computational effort, required, practically renders such approach an infeasible one, even when the vast enumeration is curtailed by branch and bound method.

Recent trends have been focused on neural network and genetic algorithm based solutions, which are highly feasible in terms of simplification of enumeration in solving a complex problem [4, 5, 6, 7], but completely infeasible in terms of understanding by the manpower working in a garments factory. It must be mentioned that garments production may be typically characterized by its low-technical requirements, and thus, these scheduling themes are not feasible. Though it is true that other heuristics are also beyond the reach of the manpower in a garments company, computer software may keep the algorithm behind the screen, requiring simple data inputs, and execution.

This study first tests lateness with different priority rules using simulation in Simple++, then uses heuristic, such as Chang and Su's algorithm, with Branch and Bound technique, and Adjacent Pairwise Interchange method, and then compares the results obtained.

3.1 Simulation Using Priority Rules

The most significant simulation study was done by Carroll using mean tardiness as the performance measure [1]. Main theme in this experiment involved a parametric family of priority dispatching rules called COVERT. Here, priority assigned to a waiting operation is the ratio between c_j and t_j, where c_j is the order delay cost and t_j is the processing time for job j. This ratio is similar to the weights assigned under Weighted SPT rule. The selection is done based on the largest ratio to be assigned next. Thus, WSPT is tested against First-Come-First-Serve (FCFS), Earliest Due Date (EDD), and Minimum Slack Time (MST), in addition with Critical Ratio (CR), rules.

The study includes 30 jobs arrived in December 2002, with their due dates (d_j), roughly estimated processing times (t_j), and penalty associated in terms of (c_j). The results obtained are as follows :

Table 1: Results of COVERT algorithm.

Dispatching rule	Mean Lateness	No. of jobs tardy (in %)
FCFS	3	33
SPT	- 5	4
EDD	1	15
MST	2	13
CR	1	10

It is found that the SPT, or WSPT prepares the best schedule for minimizing mean lateness (lateness duration) and number of jobs late. It must be noted that these are the two characteristics that garments companies need, i.e. they need to minimize average lateness along with number of latejobs

3.2 Heuristic With Branch and Bound Algorithm

The Heuristic developed by Chang and Su [2] targets to minimize both maximum lateness and number of tardy jobs, which perfectly matches the requirements in garments production also, but with the limitation that the heuristic is applicable to n jobs one-machine problem. But this garments production may be classified as a 'n jobs 3-machine' problem. Still then, an assumption may be taken into account by considering the three steps of operation as a single production unit, and then sequencing to the unit may be performed.

According to the theorem, 'For a given sequence that has n jobs with each job i having an arrival time a_i, processing time p_i, due date d_i, machine idle time I_i and non-delay lateness ℓ_i,. The maximum lateness (L_{max}) is –

$$L_{\max} = (\max_{i \in N} \; I_i + \ell_i). \qquad (1)$$

To minimize N_t (number of tardy jobs), while keeping L_{max} unchanged, the branch and bound algorithm is applied, where, lower bound is calculated as follows [2]:

Two contiguous partial schedules are defined. Set A represents the first partial schedule (partial schedule at the beginning of the schedule) involving all jobs which have already been scheduled and set B involves all the remaining unscheduled jobs not contained in set A.

LB = N_{TA} (for set A) + N_{TB} (for set B), where,

$$N_{TA} = \sum_{i \in A} f(T_i + p_{[i]} + d_{[i]}), \qquad (2)$$

$$\text{where, } f = f(x) = \begin{cases} 1 & \text{if } x>0 \\ 0 & \text{otherwise} \end{cases}$$

and N_{TB} is calculated suing Moore's algorithm.

This approach gives a result as given in Table 2.

Table 2: Lateness and No. of Jobs Tardy, using Chang and Su's algorithm.

Scheduling rule	Mean Lateness	No. of jobs tardy (in %)
Chang and Su's algorithm	- 3	2

Thus, it can be seen that both number of tardy jobs and mean lateness reduced.

3.3 Adjacent Pairwise Interchange

This algorithm [1, 3] applies the theory that maximum job lateness (L_{max}) and maximum job tardiness (T_{max}) are minimized by EDD sequencing ($d_{[1]} \leq d_{[2]} \leq \ldots d_{[n]}$). As such, an initial EDD sequence S is prepared, where there must exist a pair of adjacent jobs, i and j, with j following i, such that $d_i > d_j$. Then a new sequence S' is constructed, where jobs i and j are interchanged, and all other jobs complete at the same time as in S. Then,

$$L_i(S) = t_B + t_i - d_i; \qquad L_i(S') = t_B + t_j - d_j \qquad (3)$$

$$L_j(S) = t_B + t_i + t_j - d_j; L_i(S') = t_B + t_j + t_j - d_j , \qquad (4)$$

from which it follows that $L_j(S) > L_i(S')$ and $L_i(S) > L_j(S')$. Hence, $L_j(S) > \max \{L_i(S'), L_j(S')\}$. (5)

Let $L = \max \{L_k \mid k \in A, \text{ or } k \in B\}$, and L is the same under both S and S'. Then,

$$Lmax (S) = \max \{L, L_i(S), L_j(S)\}$$

$$\geq \max \{L, L_i(S'), L_j(S')\}=L_{max}(S') \qquad (6)$$

From this enumeration, an optimal sequence can be constructed as follows:

1. Begin with an arbitrary non-EDD sequence
2. Locate a pair of adjacent jobs i and j, with j following i, such that $d_i > d_j$
3. Interchange jobs i and j.
4. Return to step 2 iteratively until the EDD sequence is constructed. At each iteration, L_{max} either remains the same, or is reduced. Since the EDD sequence can be reached from any other sequence in this manner, there can be no other sequence with a value of L_{max} lower than that corresponding to EDD sequencing.

The results obtained from this iteration process are summarized below in table 3.

Table 3: Results of Adjacent Pairwise Interchange.

Scheduling rule	Mean Lateness	No. of jobs tardy (in %)
Adjacent Pairwise Interchange algorithm	- 2	4

4. CONCLUSIONS

It can be concluded that Chang and Su's heuristic can generate the best schedule for a garments company, though complexity of the algorithm may still advocate for WSPT priority rule as the difference between WSPT and Chang and Su's algorithm is not that significant. In that case, WSPT rule is suggested for generating schedule for garments production, as it is easy to understand for the lowly educated manpower for the sector. Computer software, written in Microsoft Excel or in Access may well serve the purpose.

5. REFERENCES

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