IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

ISSN PRINT 2319 1775 Online 2320 7876

*Research paper*  **Volume 11, Iss 8 , 2022**

# Experimental investigation on scheduling tasks through Greedy Algorithm

**Nageswara Rao Medikondu**

Department of Mechanical Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India-522302

E mail: medikondu1979@gmail.com

**DOI : 10.48047/IJFANS/V11/ISS8/342**

**Abstract.** substantial research has been conducted on flexible manufacturing systems (FMS) planning, it has predominantly centred on well-established academic layout strategies. The selection process primarily relies on fundamental principles within the intelligent system JSSE (workshop scheduling environment), with limited literature available on its application within an FMS. This article aims to investigate the performance of machine and AGV (Automated Guided Vehicle) scheduling models in reducing the number of operations within the FMS using a Greedy Algorithm (GA) approach. The methodology is evaluated under various experimental conditions through an FMS simulation model encompassing 40 different scenarios.

**Keywords:** Artificial Neural Network, Task scheduling, Artificial intelligence and Makespan

## 1. Introduction

Decision-making rules are widely employed today, and applications range from online scheduling of machines and material handling devices under real operating conditions to offline scheduling algorithms with integrated components. Panwalkar and Iskander (1977) documented over 100 rules, distinguishing between scheduling rules, dispatching rules, and priority rules. Further literature on these rules can be found in works by Conway et al. (1967), Blackstone et al. (1982), Kiran and Smith (1984a, b). Scheduling rules are utilized to prioritize machines and AGVs based on completion times, including travel times. Egbelu and Tanchoco (1984) proposed scheduling rules for dispatching AGVs, while Acree and Smith (1985) explored selection rules in FMS. Recent research trends are geared toward the implementation of intelligent systems in scheduling problems as opposed to traditional job shop scheduling, compared to experimental studies in FMS (Sabuncuoglu and Hommertzheim 1989b). Stecke and Solberg (1981) examined heuristic rules in FMS with ten machines and two AGVs, while Denzler and Boe (1987) delved into AGV routing, including operation time data, with experimental investigations of FMS. Choi and Malstrom (1988) addressed the FMS scheduling model, focusing on a small closed-loop FMS with two microcomputers and formulated two rules related to part and machine selection. Montazeri and Wassenhove (1989) conducted an investigation of several rules for FMS performance. Co et al. (1988) presented scheduling rules for a closed-loop FMS, concluding that not all scheduling rules are critical in a job shop scenario. Egbelu and Tanchoco (1984) studied the scheduling of AGVs and machines, emphasizing that finding the best cart selection rule was challenging. In conclusion, Sabuncuoglu and Hommertzheim (1989a) developed scheduling rules based on their study, highlighting the importance of AGVs scheduling over machine scheduling. To gain a better understanding, FMS scheduling problems are addressed using scheduling rules under different conditions, encompassing material handling and machine aspects. These rules can be classified into two categories: scheduling of machines and scheduling of AGVs. Among these, the Greedy Algorithm (GA) rule stands out as a fundamental approach to job completion, especially when considering high AGV speeds.

## 2. Greedy Algorithm Design

The input data for this study is derived from the research conducted by Bilge and Ulusoy in 1995. This dataset includes information on a series of machines, their respective processing times, and a matrix representing the travel times between these machines. The configuration, as depicted in Figure 1, involves four CNC machines that are equipped with pallet changers and a set of tools.

IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

ISSN PRINT 2319 1775 Online 2320 7876

*Research paper*  Volume 11, Iss 8 , 2022

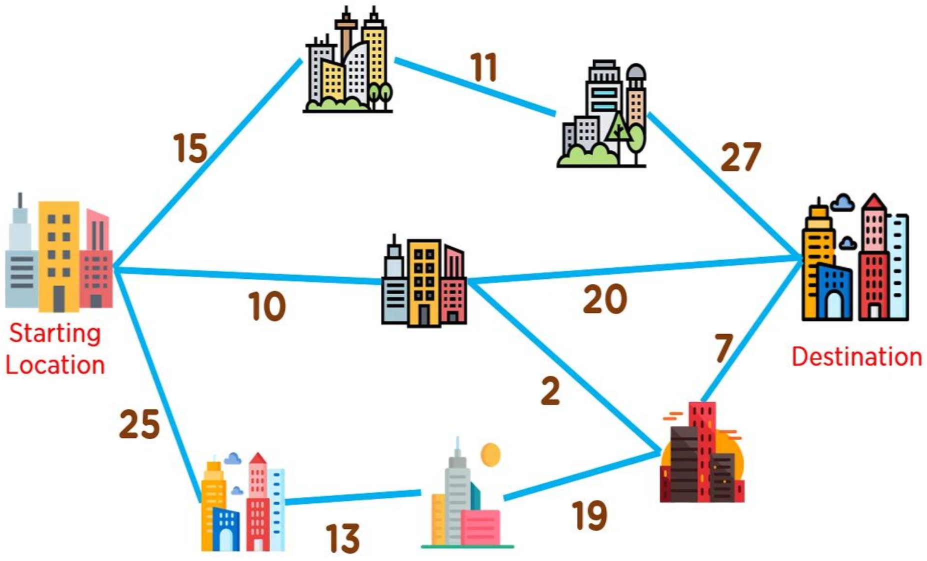


**Figure 1**: Basic structure of Greedy Algorithm

### 2.1. Methodology

Layout 2 and Job set 5 play a crucial role in the execution of the Greedy Algorithm (GA) as an example with half the movement time and double the process time. The GA is explained in the following steps for Job Set 5:

Step 1: Consider Job Set 5. Step 2: Initially, place item '1' at the beginning of the primary line, arranged as follows: 1 – 2 - 3 - 4 - 5 - 6 - 7 – 8 – 9 – 10 - 11 - 12 - 13. Step 3: Determine the maximum completion time, representing the possible completion time (makespan) for the given job set.

Table 1 displays the specific constraints for all the activities involved in the GA:

**Table 1.** Completion Time Using GA

| Order | Machine | Operation | TT | JRT | Job Reach Time | Process Time | Makespan |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 3 | 2 | 6 | 14 |
| 2 | 2 | 2 | 27 | 30 | 15 | 12 | 39 |
| 3 | 4 | 1 | 78 | 82 | 41 | 9 | 59 |
| 4 | 1 | 2 | 35 | 38 | 21 | 18 | 57 |
| 5 | 3 | 2 | 98 | 102 | 59 | 6 | 71 |
| 6 | 2 | 1 | 132 | 135 | 77 | 15 | 107 |
| 7 | 3 | 2 | 106 | 111 | 71 | 9 | 89 |
| 8 | 4 | 2 | 168 | 171 | 90 | 3 | 96 |
| 9 | 1 | 1 | 195 | 200 | 100 | 12 | 124 |
| 10 | 4 | 2 | 174 | 180 | 96 | 6 | 108 |
| 11 | 2 | 2 | 237 | 241 | 113 | 15 | 143 |
| 12 | 3 | 1 | 103 | 107 | 107 | 3 | 113 |
| 13 | 1 | 1 | 113 | 118 | 124 | 9 | 142 |

Table 1 illustrates the activity scheduling through the GA algorithm for Job Set 5, resulting in a total completion time (makespan) of 143.

Total completion time = 1162

Average flow time = Total completion time / Total number of operations = 1162 / 13 = 89.38 Average number of operations in the FMS = Total Flow Time / Makespan = 1162 / 143 = 9

## 3. Results and Discussion

ISSN PRINT 2319 1775 Online 2320 7876
*Research paper*  **Volume 11, Iss 8 , 2022**

The results must be presented in a clear and concise manner, focusing on the most significant or primary findings of the research. In the discussion section, it is essential to delve into the importance of the research outcomes.

The workshop scenario described for Flexible Manufacturing Systems (FMS) involves the utilization of Job Set Model 5 and Layout 2

| Problem. No | Lay out | No of Operations in Greedy System |
|---|---|---|
| P1 | 1 | 7 |
| P 2 | 1 | 8 |
| P 3 | 1 | 8 |
| P 4 | 1 | 10 |
| P 5 | 1 | 8 |
| P 6 | 1 | 10 |
| P 7 | 1 | 10 |
| P 8 | 1 | 11 |
| P 9 | 1 | 9 |
| P 10 | 1 | 11 |
| P1 | 2 | 7 |
| P 2 | 2 | 8 |
| P 3 | 2 | 8 |
| P 4 | 2 | 10 |
| P 5 | 2 | 8 |
| P 6 | 2 | 10 |
| P 7 | 2 | 10 |
| P 8 | 2 | 11 |
| P 9 | 2 | 9 |
| P 10 | 2 | 11 |
| P1 | 3 | 7 |
| P 2 | 3 | 8 |
| P 3 | 3 | 8 |
| P 4 | 3 | 10 |
| P 5 | 3 | 8 |
| P 6 | 3 | 10 |
| P 7 | 3 | 10 |
| P 8 | 3 | 11 |
| P 9 | 3 | 9 |
| P 10 | 3 | 12 |
| P1 | 4 | 7 |
| P 2 | 4 | 8 |
| P 3 | 4 | 8 |
| P 4 | 4 | 10 |
| P 5 | 4 | 7 |
| P 6 | 4 | 10 |
| P 7 | 4 | 17 |
| P 8 | 4 | 11 |
| P 9 | 4 | 9 |
| P 10 | 4 | 11 |

In the context of optimizing the arrangement of Automated Guided Vehicles (AGVs) and machines, priority rules are employed to manage three distinct processing time values. These rules are outlined in

ISSN PRINT 2319 1775 Online 2320 7876
 **Volume 11, Iss 8 , 2022**

two separate tables. An analysis of the makespan and mean flow time across different job sets and layouts is visually represented in Figures 2.

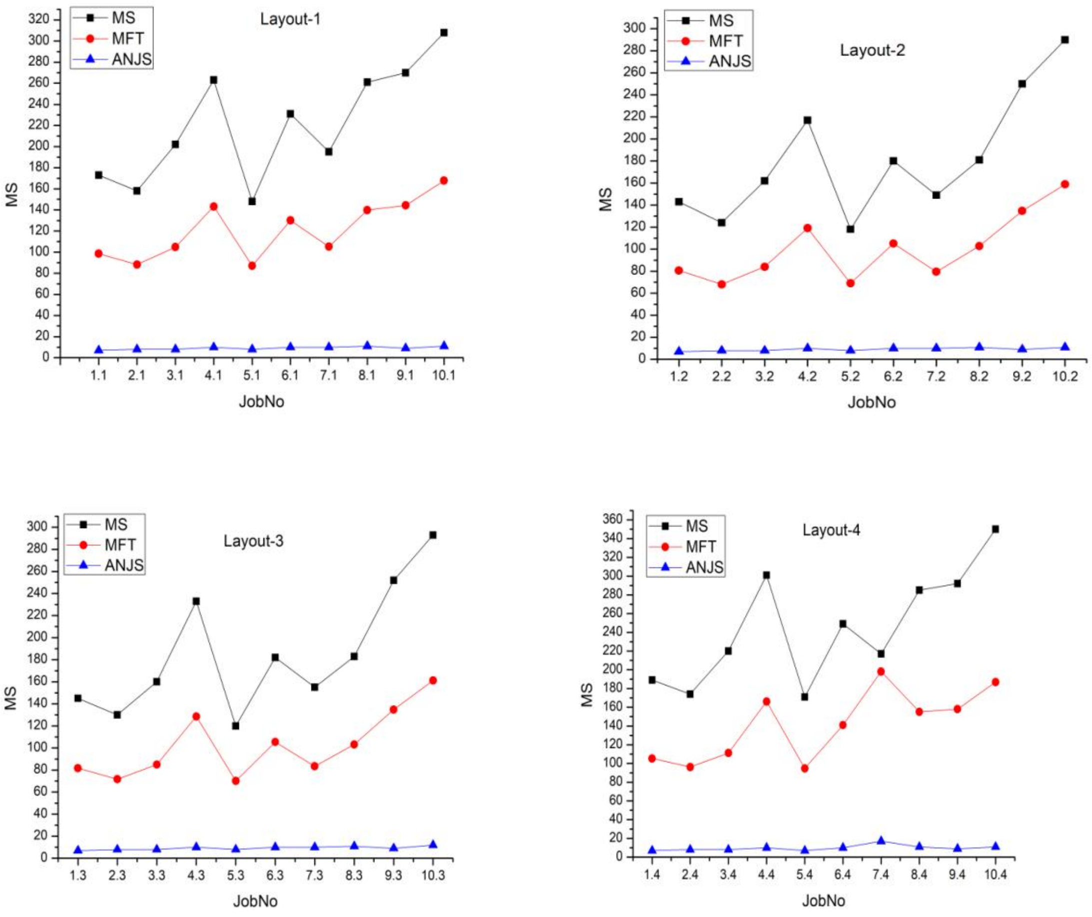


Figure 2: Make span Vs Mean flow time (t/p<0.25)

## 4. Conclusions.

FMS problems are addressed using a Greedy Algorithm (GA) aimed at minimizing the number of operations within a system containing four layouts, each equipped with four identical machines and two material handling systems. This study encompasses not only machine scheduling but also the scheduling of Automated Guided Vehicles (AGVs), with the following results: The research indicates that an increase in the number of jobs within the system leads to a corresponding rise in machine and AGV utilization. Notably, the distribution of completion times in the FMS is greatly influenced by the number of operations in the system. When both AGV and machine loads increase due to scheduling rules, the number of operations in the system becomes crucial as it directly impacts the overall utilization of the FMS. This, in turn, results in an increase in job tardiness. The GA rule was tested with a system involving 40 operations, and it consistently outperformed other approaches, including AGV-based rules. Future endeavours should focus on the development and implementation of new rules within the FMS environment, allowing for continuous testing with various objective functions.

## Acknowledgements

DST-SERB, GOI, (Sanction No: SB/EMEQ-501/2014)

## References

ISSN PRINT 2319 1775 Online 2320 7876

*Research paper*  **Volume 11, Iss 8 , 2022**

1. E.S. Acree and M.L. Smith, "Simulation of flexible manufacturing system applications of computer operating system techniques," in the 18th Annual Simulation Symposium, pp. 205-216, IEEE Computer Society Press, Tampa, Florida, 1985.
2. J.A. Buzacott and D.D. Yao, "Flexible manufacturing systems: a review of analytical models," Management Science, vol. 32, no. 7, pp. 890-905, 1985.
3. J.H. Blackstone et al., "A state-of-the-art survey of dispatching rules for manufacturing job shop operations," International Journal of Production Research, vol. 20, no. 1, pp. 27-45, 1982.
4. J. Browne et al., "Classification of flexible manufacturing systems," The FMS Magazine, April, pp. 114-117, 1984.
5. H.C. Co, T. Jaw, and S.K. Chen, "Sequencing in flexible manufacturing systems and other short queue-length systems," Journal of Manufacturing Systems, vol. 7, no. 1, pp. 1-7, 1988.
6. R.H. Choi and E.M. Malstrom, "Evaluation of traditional work scheduling rules in a flexible manufacturing system with a physical simulator," Journal of Manufacturing Systems, vol. 7, no. 1, pp. 33-45, 1988.
7. R.W. Conway, "Some tactical problems in digital simulation," Management Science, vol. 10, no. 1, pp. 47-61, 1963.
8. R.W. Conway et al., "Theory of Scheduling," Addison-Wesley, Reading, Mass., 1967.
9. G.C. Dupon, "A survey of flexible manufacturing systems," Journal of Manufacturing Systems, vol. 1, no. 1, pp. 1-16, 1982.
10. P.J. Egbelu, "Pull versus push strategy for automated guided vehicle load movement in a batch manufacturing system," Journal of Manufacturing Systems, vol. 6, no. 3, pp. 209-221, 1987.
11. P.J. Egbelu and J.M.A. Tanchoco, "Characterization of automated guided vehicle dispatching rules," International Journal of Production Research, vol. 22, no. 3, pp. 359-374, 1984.
12. P.A. Kumar et al., "Scheduling of machines and automated guided vehicles in FMS using scatter search algorithm," International Journal of Mechanical Engineering and Technology, vol. 8(5), pp. 471-481, 2017.
13. K.V. Subbaiah, M. Nageswara Rao, K. Narayana Rao, "Scheduling of AGVs and Machines in FMS with Make Span Criteria Using Sheep Flock Heredity Algorithm," International Journal of Physical Sciences, vol. 4(2), pp. 139-148, 2009.
14. M. Nageswara Rao, S. Vara Kumari, P. Manohar, B. Madesh, P. Naveen Krishna, R. Suraj Krishna, "Simultaneous Scheduling of Machines and AGVs in FMS Through Ant Colony Optimization Algorithm," International Journal of Engineering and Advanced Technology, vol. 9(3), pp. 1392-1397, 2020.
15. M. Nageswara Rao et al., "Simultaneous Scheduling of Machines and AGVs in FMS through Simulated Annealing Algorithm," International Journal of Innovative Technology and Exploring Engineering, vol. 9(4), pp. 2235-2240, 2020.
16. M. Nageswara Rao, et al., "Application of BPSO in flexible manufacturing system scheduling," International Journal of Mechanical Engineering and Technology, vol. 8(5), pp. 186-195, 2017.