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# Comparative Study: Preemptive Shortest Job First and Round Robin Algorithms

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**Abstract**: Operating system is a software acting as an interface between computer hardware and user. Operating system is known as a resource manager. The main responsibility of operating system is to handle resources of computer system. Scheduling is a key concept in computer multitasking and multiprocessing operating system design by switching the CPU among process. Shortest job first (SJF) and round robin are two wellknown algorithms in CPU processing. For shortest job first, this algorithm can be preemptived. In preemptive shortest job first, when a new process coming in, the process can be interupted. Where with round robin algorithm there will be time slices, context switching, or also called quantum, between process. In this journal we will discuss comparative study between preemptive shortest job first and round robin algorithms. Three comparative studies will be discussed to understand these two algorithms more deeply. For all comparative study, the average waiting time and average turnaround time is more for round robin algorithm. In the first comparative study, we get average waiting time 52% more. For average turnaround time, 30% more. In second comparative analysis, we get 52 % average waiting time more and we get 35 % average turnaround time more. For third comparative analysis, average waiting time we get 50% more and for average turnaround time, we get 28% more. Thus it is concluded in our comparative study for these kind of data the preemptive shortest job first is more efficient then the round robin algorithm. This research is to compare between preemptive shortest job first and round robin algorithms to compare its efficiency. Which one is more efficient then the other. Comparison between average turnaround time and average waiting time.

**Keywords**: comparative study, premptive shortest job first algorithm, round robin algorithm, turn around time, average waiting time, time slice

## INTRODUCTION

Operating system is a software acting as an interface between computer hardware and user. Operating system is known as a resource manager. The main responsibility of operating system is to handle resources of computer system. Scheduling is very important. The rules in scheduling, mechanism and policy of scheduling are important to govern which resources allocated for burst time. In order to manage many queues of processes to minimize delay and make performance system's optimum. In operating system, there is a scheduler which implements the scheduling policy. The main goal of scheduling in operating system is to make performance system optimum in line with criteria set by system designer. (Purnomo & Putra, 2022) (Purnomo & Putra, 2022; Putra, 2020a, 2020b; Putra & Purnomo, 2021, 2022b, 2022a; Tri Dharma Putra, 2021).

There are several wellknown CPU scheduling algorithms. first comes first serve (FCFS), priority scheduling, longest job first, shortest remaining time first, longest remaining time first, multiple queue scheduling, multilevel feedback queue scheduling. The most known are two of them, are preemptive shortest job first (SJF) and round robin algorithms.

This research is to compare the efficiency of preemptive shortest job first and round robin algorithms. Which one is more efficient than the other. Analysis is given in terms of efficiency of average turnaround time and average waiting time.

Below are several parameter in scheduling to say that its performance is optimum:

1) CPU Usage: CPU must always busy at 100% of time.
2) Throughput: The processes which executing in that moment of time
3) Turnaround time: Time of process from arrival time until process burst time finished.

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4) Waiting time: The time in which process waiting to be executed in the ready queue.
5) Response time: The time when the request made and the reception, to the first response (Ali et al., 2021).

The following conditions must be achieved to make scheduling optimum: CPU usage must be higher, throughput must be higher, turnaround time must be lower, waiting time must be lower, and response time must be lower.

This is the organizational of this journal: We divide it into five chapters. In the first chapter the discussion is about the background idea about theories of scheduling. This is introduction. Second chapter is about the concept behind the preemptive shortest job first and round robin algorithms. In the third chapter we discuss about comparative study, actually three comparative studies. The fourth chapter is about analysis. The last chapter, chapter fifth, is conclusion.

## METHODS

Here are several steps in terms of methodology. There are six steps. The first step is selecting the topic. The second is searching literature. The third step is develop the argument. The fourth step is survey the literature and the fifth is critique the literatur and the last step is writing the review. In this journal, analysis is given in terms of preemptive shortest job first and round robin algorithms. In the stage of critique the literatur, analysis is given in terms of efficienty of preemptive shortest job first and round robin algorithm. The last stage is simply write this journal. Please take a look and figure 1 below.

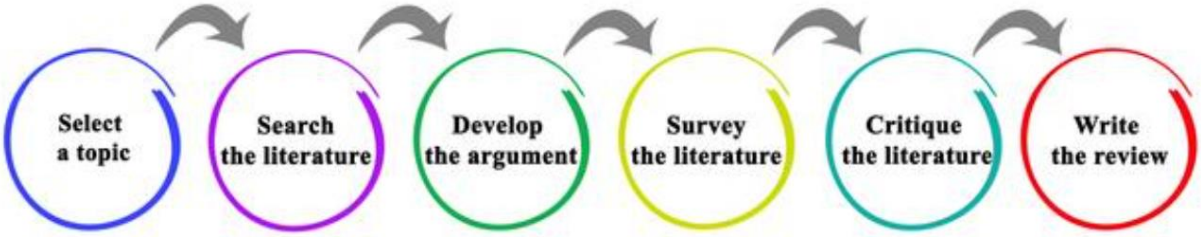


Figure 1. stage of literature review

To discuss the method of preemptive shortest job first and round robin algorithms, let us analyze this table 1. below. Let say we have some process with arrival times and burst times as below:

Table 1. A set of four processes with time of arrival and burst time

| Process | Time of Arrival | Burst Duration |
|---|---|---|
| Q1 | 0 | 4 |
| Q2 | 1 | 2 |
| Q3 | 2 | 3 |
| Q4 | 3 | 3 |

a) Preemptive Shortest Job First.

One well known scheduling algorithm is preemptive shortest job first. The ready queue, in this algorithm, is organized in line with the process's burst time. The process with the lowest burst time to its completions is placed in front of the queue. This is also an algorithm with preemption. The process which is running can be preemptived and the small burst time of new process starts its execution. If process completes from its execution, then it will be terminated and be removed from list of waiting process (Asma Joshita Trisha, 2019). Then, a new process will be selected for execution from the ready queue.

This algorithm usually appropriate for batch process, since the run times are known before its execution. The shortest job first (SFJ) will suffer from starvation in long process, however may be optimal for a set of process (Siahaan, 2016). However, premptive shortest job first is not practical, since the task execution is not known in advance (Chandra Shekar N, 2017) (Freire et al., 2021).

Please take a look at table 1. above. Then after analysis of preemptive shortest job first, we get the gantt chart as in figure 1. Below. Q1 is executed first, But at 1 ms, Q1 is premptived by Q2, since Q2 is shortest than Q1. Afterwards, Q2 is finished until 3 ms. Then Q1 is executed again until 6 ms, then Q3, and Q4 afterwards. Here we can see that at 2 ms, Q1 is preemptved by Q2, since Q2 is 2 ms and Q1 is still 3 ms. Q2 is shorter than Q1.

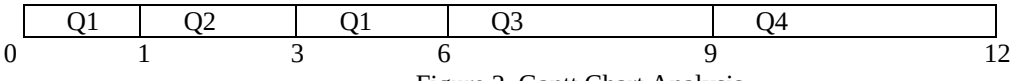


Figure 2. Gantt Chart Analysis

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b) Round Robin Algorithm.

For round robin algorithm, time slice or also called context switching is used (Abu-Dalbouh, 2022)(Shafi et al., 2020)(Mostafa & Amano, 2020)(Alhaidari & Balharith, 2021). In this algorithm, every process is given with a fixed time slot. Round robin algorithm can be considered as a version of first come first serve scheduling with preemption. Round robin is simple and easy to use. All processes get a fair allocation of CPU. Every process is given a limited time shared by CPU, thus, it is considered as an algorithm with preemption. The preemptive method of round robin to run is called context switching, quantum, or time slice. The process will get back to the waiting queue table to wait its next round if the the current process finish the execution. Every process will get a fair CPU time. The next round of process will be executed if the current process finish below its time slice. Hence, each process will get an allocated CPU time, which will eliminate the starvation(Omar et al., 2021)(Purnomo & Putra, 2022). One the most disadvantage of round robin algorithm is more overhead of quantum or context switching.

To discuss the round robin algorithm, let us use the table 1., the same table with preemptive shortest job first. Above. Let us use time slice equals to 3.

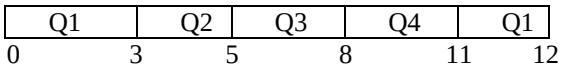


Figure 3. Gantt Chart Analysis

Please take a look at figure 2. Above. In this round robin, Q1 is executed first for 3 ms, since the quantum is 3. Q1 is left with 1 ms.Then Q2 is executed until finish until 5. Then Q3 and Q4, since the quantum is 3. At last, Q1 is executed again for 1 ms, for the second round. Then it is finish.

## RESULTS

Three comparative study will be discussed in this section about preemptive shortest job first and round robin algorithms. Comparative study between the two will be discussed. Every process has arrival time and also burst time. Below is the discussion of each one of it:

### a) Comparative Study 1

Arrival times and burst times are given for five processes. All of them is, off course, are for preemptive shortest job first algorithm and round robin algorithm scheduling. Please take a look at table 2. below:

Table 2. A set of five processes with time of arrival and burst time

| Process | Time of Arrival | Burst Duration |
|---|---|---|
| Q1 | 0 | 4 |
| Q2 | 2 | 3 |
| Q3 | 4 | 6 |
| Q4 | 7 | 8 |
| Q5_ | 8 | 9 |

**Preemptive Shortest Job First Algorithm**

After analyzing the burst time, we get the gantt chart as per the figure 3. below. The gantt chart ends at 30 ms. All the processes is executed from 0 until 30 ms:

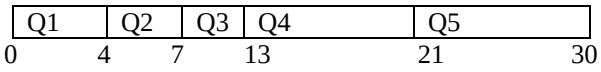


Figure 4. Gantt Chart Analysis

Based on the analysis of gantt chart of figure 1., we get the table of performance analysis. Here is the table 3. for analysis and performance:

Table 3. Time processes and performance analysis

| Process | Time of arrival | Burst Duration | Start time | Finish time | Turnaround time |
|---|---|---|---|---|---|
| Q1 | 0 | 4 | 0 | 4 | 4 |
| Q2 | 2 | 3 | 4 | 7 | 5 |

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| | | | | | |
|---|---|---|---|---|---|
| Q3 | 4 | 6 | 7 | 13 | 9 |
| Q4 | 7 | 8 | 13 | 21 | 14 |
| Q5 | 8 | 9 | 21 | 30 | 22 |

From analysis of table performance and gantt chart above, we get the average waiting time and average turnaround time, as follows:

The average waiting time is (0+2+3+6+13)/5 = 4.8

The average turnaround time is (4+5+9+14+22)/5 = 10.8

**Round Robin Algorithm**

For round robin algorithm, we must choose a time quantum to be used. Here, analysis for round robin algorithm with context switching equals to 3.

After analyzing the burst time, we get the gantt chart as per the figure 4. below. The gantt chart ends at 30 ms. All the processes is executed from 0 until 30 ms:

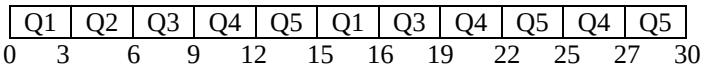


Figure 5. gantt chart analysis

Based on the analysis of gantt chart of figure 4., we get the table of performance analysis. Here is the table 4. for analysis and performance:

Table 4. Time Process and Performance analysis

| Process | Time of arrival | Burst Duration | Start time | Finish time | Trunaround time |
|---|---|---|---|---|---|
| Q1 | 0 | 4 | 0 | 16 | 16 |
| Q2 | 2 | 3 | 3 | 6 | 4 |
| Q3 | 4 | 6 | 6 | 19 | 15 |
| Q4 | 7 | 8 | 9 | 27 | 20 |
| Q5 | 8 | 9 | 12 | 30 | 22 |

From analysis of table performance and gantt chart above, we get the average waiting time and average turnaround time, as follows:

The average waiting time is (12+1+9+12+16)/5=10
The average turnaround time is (16+4+15+20+22)/5=15.4

**b) Comparative Study 2**

Arrival times and burst times are given for five processes. All of them is, off course, are for preemptive shortest job first algorithm and round robin algorithm scheduling. Please take a look at table 5. below:

Table 5. A set of five processes with time of arrival and burst time

| Processes | Time of Arrival | Burst Duration |
|---|---|---|
| Q1 | 0 | 4 |
| Q2 | 2 | 6 |
| Q3 | 4 | 5 |
| Q4 | 7 | 8 |
| Q5_ | 8 | 9 |

**Preemptive Shortest Job First Algorithm**

After analyzing the burst time, we get the gantt chart as per the figure 5. below. The gantt chart ends at 32 ms. All the processes is executed from 0 until 32 ms:

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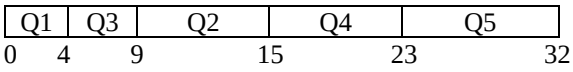

Figure 6. Gantt Chart Analysis

Based on the analysis of gantt chart of figure 5., we get the table of performance analysis. Here is the table 6. for analysis and performance:

Table 6. Time processes and performance analysis

| Process | Time of arrival | Burst Duration | Start time | Finish time | Turnaround time |
|---|---|---|---|---|---|
| Q1 | 0 | 4 | 0 | 4 | 4 |
| Q2 | 2 | 6 | 9 | 15 | 13 |
| Q3 | 4 | 5 | 4 | 9 | 5 |
| Q4 | 7 | 8 | 15 | 23 | 16 |
| Q5 | 8 | 9 | 23 | 32 | 24 |

From analysis of table performance and gantt chart above, we get the average waiting time and average turnaround time, as follows:

The average waiting time is (0+7+0+8+15)/5=6

The average turnaround time is (4+13+5+16+24)/5= 12.4

**Round Robin Algorithm**

For round robin algorithm, we must choose a time quantum to be used. Here, analysis for round robin algorithm with context switching equals to 3.

After analyzing the burst time, we get the gantt chart as per the figure 6. below. The gantt chart ends at 32 ms. All the processes is executed from 0 until 32 ms:

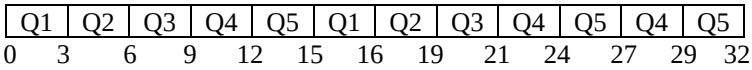

Figure 7. Gantt Chart Analysis

Based on the analysis of gantt chart of figure 6., we get the table of performance analysis. Here is the table 7. for analysis and performance:

Table 7. Time Process and Performance Analysis

| Process | Time of arrival | Burst Duration | Start time | Finish time | Trunaround time |
|---|---|---|---|---|---|
| Q1 | 0 | 4 | 0 | 16 | 16 |
| Q2 | 2 | 6 | 3 | 19 | 17 |
| Q3 | 4 | 5 | 6 | 21 | 17 |
| Q4 | 7 | 8 | 9 | 29 | 22 |
| Q5 | 8 | 9 | 12 | 32 | 24 |

From analysis of table performance and gantt chart above, we get the average waiting time and average turnaround time, as follows:

The average waiting time is (12+11+12+14+15)/5=12.8
The average turnaround time is (16+17+17+22+24)=19.2

**c) Comparative Study 3**

Still, the discussion is about the preemptive shortest job first and round robin algorithms. Arrival times and burst times are given for five processes. All of them is, off course, are for preemptive shortest job first algorithm and round robin algorithm scheduling. Please take a look at table 8. below:

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Table 8. A set of five processes with time of arrival and burst time

| Processes | Time of Arrival | Burst Duration |
|---|---|---|
| Q1 | 0 | 4 |
| Q2 | 2 | 3 |
| Q3 | 4 | 3 |
| Q4 | 7 | 1 |
| Q5_ | 8 | 2 |

**Preemptive Shortest Job First Algorithm**

After analyzing the burst time, we get the gantt chart as per the figure 7. below. The gantt chart ends at 13 ms. All the processes is executed from 0 until 13 ms:

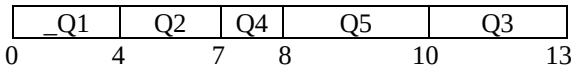


Figure 8. Gantt Chart Analysis

Based on the analysis of gantt chart of figure 7., we get the table of performance analysis. Here is the table 9. for analysis and performance:

Table 9. Time processes and performance analysis

| Process | Time of arrival | Burst Duration | Start time | Finish time | Turnaround time |
|---|---|---|---|---|---|
| Q1 | 0 | 4 | 0 | 4 | 4 |
| Q2 | 2 | 3 | 4 | 7 | 5 |
| Q3 | 4 | 3 | 10 | 13 | 9 |
| Q4 | 7 | 1 | 7 | 8 | 1 |
| Q5 | 8 | 2 | 8 | 10 | 2 |

From analysis of table performance and gantt chart above, we get the average waiting time and average turnaround time, as follows:
The average waiting time is (0+2+6+0+0)/5 = 1.6
The average turnaround time is (4+5+9+1+2)/5 = 4.2

**Round Robin Algorithm**

For round robin algorithm, we must choose a time quantum to be used. Here, analysis for round robin algorithm with context switching equals to 3.

After analyzing the burst time, we get the gantt chart as per the Figure 8. below. The gantt chart ends at 13 ms. All the processes is executed from 0 until 13 ms:

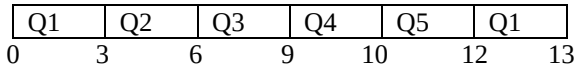


Figure 9. Gantt Chart Analysis

Based on the analysis of gantt chart of figure 8., we get the table of performance analysis. Here is the table 9. for analysis and performance:

Table 10. Time Process and Performance Analysis

| Process | Time of Arrival | Burst Time | Start Time | Finish time | Turnaround time |
|---|---|---|---|---|---|
| Q1 | 0 | 4 | 0 | 13 | 13 |
| Q2 | 2 | 3 | 3 | 6 | 4 |
| Q3 | 4 | 3 | 6 | 9 | 5 |

*name of corresponding author

| | | | | | |
|---|---|---|---|---|---|
| Q4 | 7 | 1 | 9 | 10 | 3 |
| Q5 | 8 | 2 | 10 | 12 | 4 |

From analysis of table performance and gantt chart above, we get the average waiting time and average turnaround time, as follows:
The average waiting time is (9+1+2+2+2)=16/5=3.2
The average turnaround time is (13+4+5+3+4)= 29/5=5.8

## DISCUSSION

Below is the table of recapitulation of performance of these two algorithms. Please take a look at table 11.

Table 11. Recapitulation of Performance

| | Algorithm | Average Waiting Time (ms) | Turnaround Time (ms) |
|---|---|---|---|
| Comparative Analysis 1 | Preemptive Shortest Job First | 4.8 | 10.8 |
| | Round Robin | 10 | 15.4 |
| Comparative Analysis 2 | Preemptive Shortest Job First | 6 | 12.4 |
| | Round Robin | 12.8 | 19.2 |
| Comparative Analysis 3 | Preemptive Shortest Job First | 1.6 | 4.2 |
| | Round Robin | 3.2 | 5.8 |

For comparative study 1, preemptive shortest job first, we get 4.8 ms for average waiting time and 10.8 ms for average turnaround time. Both are in millisecond. However, for round robin algorithm we get average waiting time 10 ms and average turnaround time 15.4 ms. For the comparative study 2, preemptive shortest job first, we get 6 ms for average waiting time and 12.4 ms for average turnaround time. On the contrary for round robin algorithm, we get 12.8 ms for average waiting time and 19.2 ms for average turnaround time. For the comparative study 3, preemptive shortest job first, we get 1.6 ms for average waiting time and 4.2 for average turnaround time. However for round robin algorithm, we get 3.2 ms for average waiting time and 5.8 ms for average turnaround time.

## CONCLUSION

It is concluded that the shortest job first for these data of comparative studies are more efficient than the round robin algorithm. Since we get lower average waiting time and lower average turnaround time for all comparative studies for preemptive shortest job first. In the comparative study 1, for round robin, we get average waiting time 52% more than the shortest job first algorithm. For average turnaround time, round robin, we get 30% more than shortest job first for average turnaround time. In comparative analysis 2, for round robin, we get 52 % average waiting time more than shortest job first algorithm and we get 35 % average turnaround time more in round robin than the shortest job first algorithm. At last for comparative study 3, the analysis, for round robin, for average waiting time we get 50% more than the shortest job first algorithm and for average turnaround time, for round robin, we get 28% more than the shortest job first algorithm. Thus, it is concluded in our comparative study for these kinds of data the preemptive shortest job first is more efficient than the round robin algorithm. For future works, we suggest to compare other algorithms like other variants of round robin, average max round robin, improved round robin, intelligent round robin, with preemptive shortest job first. Also, for round robin algorithm, it is suggested to use different context switching and analyze the result.

## REFERENCES

Abu-Dalbouh, H. M. (2022). A New Combination Approach to CPU Scheduling based on Priority and Round-Robin Algorithms for Assigning a Priority to a Process and Eliminating Starvation. *International Journal of Advanced Computer Science and Applications*, *13*(4), 541–546. https://doi.org/10.14569/IJACSA.2022.0130463

Alhaidari, F., & Balharith, T. Z. (2021). Enhanced round-robin algorithm in the cloud computing environment for optimal task scheduling. *Computers*, *10*(5). https://doi.org/10.3390/computers10050063

Ali, S. M., Alshahrani, R. F., Hadadi, A. H., Alghamdi, T. A., Almuhsin, F. H., & El-Sharawy, E. E. (2021). A

*name of corresponding author

Review on the CPU Scheduling Algorithms: Comparative Study. *International Journal of Computer Science & Network Security*, *21*(1), 19–26. https://doi.org/10.22937/IJCSNS.2021.21.1.4

Asma Joshita Trisha, S. B. (2019). A Combined Preemptive SJF and Preemptive Priority Algorithm to Enhance CPU Utilization. *International Journal of Computer Applications*, *177*(19), 26–30.

Chandra Shekar N, K. V. (2017). Analysis of Priority Scheduling Algorithm on the Basis of FCSF & SJF for Similar Priority Jobs. *International Journal of Engineering Research in Computer Science and Engineering*, *4*(3), 73–76.

Freire, D. L., Frantz, R. Z., Roos-frantz, F., & Fernandes, V. B. (2021). *New developments in Round Robin algorithms and their applications : a systematic mapping study New developments in Round Robin algorithms and their applications : a systematic mapping study Daniela L . Freire , Rafael Z . Frantz , Fabricia Roos-Frantz Vit. January*.

Mostafa, S. M., & Amano, H. (2020). An adjustable variant of round robin algorithm based on clustering technique. *Computers, Materials and Continua*, *66*(3), 3253–3270. https://doi.org/10.32604/cmc.2021.014675

Omar, H. K., Jihad, K. H., & Hussein, S. F. (2021). Comparative analysis of the essential cpu scheduling algorithms. *Bulletin of Electrical Engineering and Informatics*, *10*(5), 2742–2750. https://doi.org/10.11591/eei.v10i5.2812

Purnomo, R., & Putra, T. D. (2022). Comparison Between Simple Round Robin and Improved Round Robin Algorithms. *JATISI (Jurnal Teknik Informatika Dan Sistem Informasi)*, *9*(3), 2205–2221. https://doi.org/10.35957/jatisi.v9i3.2547

Putra, T. D. (2020a). Analisis Keranjang Belanja dengan Algoritma Apriori Klasik pada Data Mining. *Jurnal Kajian Ilmiah*, *20*(1). https://doi.org/10.31599/jki.v20i1.70

Putra, T. D. (2020b). Analysis of Preemptive Shortest Job First (SJF) Algorithm in CPU Scheduling. *IJARCCE*, *9*(4), 41–45. https://doi.org/10.17148/ijarcce.2020.9408

Putra, T. D., & Purnomo, R. (2021). Analisis Algoritma Round Robin pada Penjadwalan CPU. *Jurnal Ilmiah Teknologi Informasi Asia*, *15*(2), 85. https://doi.org/10.32815/jitika.v15i2.481

Putra, T. D., & Purnomo, R. (2022a). Case Study : Improved Round Robin Algorithm. *Sinkron : Jurnal Dan Penelitian Teknik Informatika*, *7*(3), 950–956.

Putra, T. D., & Purnomo, R. (2022b). Simulation of Priority Round Robin Scheduling Algorithm. *Sinkron*, *7*(4), 2170–2181. https://doi.org/10.33395/sinkron.v7i4.11665

Shafi, U., Shah, M., Wahid, A., Abbasi, K., Javaid, Q., Asghar, M., & Haider, M. (2020). A novel amended dynamic round robin scheduling algorithm for timeshared systems. *International Arab Journal of Information Technology*, *17*(1), 90–98. https://doi.org/10.34028/iajit/17/1/11

Siahaan, A. P. U. (2016). Comparison Analysis of CPU Scheduling: FCFS, SJF and Round Robin. *International Journal of Engineering Development and Research*, *4*(3), 124–131.

Tri Dharma Putra, A. F. (2021). Comparison Between Simple Round Robin and Intelligent Round Robin Algorithms in CPU Scheduling. *International Journal of Advanced Research in Computer and Communication Engineering*, *10*(4), 86–90.

*name of corresponding author