LAPORAN TUGAS ACTIVITY 7

Pemodelan Simulasi (B)

Conveyor and Processing Problem

Dosen: Prof. Dr. Ir. Joko Lianto Buliali, M.Sc.

Penyusun:

Hans Sanjaya Yantono	5025231034	Hadir
Ahmad Muqorrobin	5025231254	Hadir
Muhammad Faisal Rafi	5025231295	Hadir

DEPARTEMEN TEKNIK INFORMATIKA
FAKULTAS TEKNOLOGI DAN INFORMATIKA CERDAS
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA

2025

Conveyor and Processing Problem (Mayoritas NRP Genap)

Gambaran Simulasi:

A small manufacturing system consisting of a conveyor and a processing tool. Raw parts arrive at regular intervals, move along a conveyor, and are processed by a single machine before being sent out of the system. Parts arrive every 5 minutes (deterministic arrival). The conveyor transports each part to the machine; the conveyor travel is 1 minute (deterministic arrival). The machine processes each part for a normally distributed time with: mean = 4 minutes, Standard deviation = 1 minute. The system runs for 12 hours. The machine can only process one part at a time. If the machine is busy, arriving parts must wait in a queue before processing.

Task:

1. Report the average queue length before the machine

2. Report the average processing time per part

3. Repost the number of parts completed by the end of simulation

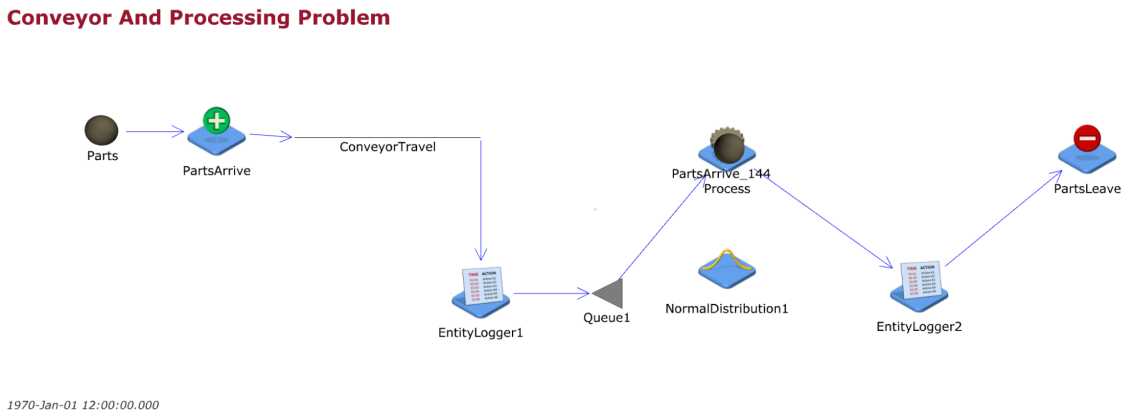
Sebuah sistem manufaktur kecil terdiri dari sebuah *conveyor* dan sebuah alat pemrosesan. Suku cadang mentah tiba secara berkala, bergerak di sepanjang conveyor, dan diproses oleh satu mesin sebelum dikirim keluar dari sistem. Suku cadang tiba setiap 5 menit secara deterministik. *Conveyor* mengangkut setiap suku cadang ke mesin; waktu tempuh *conveyor* adalah 1 menit secara deterministik. Mesin memproses setiap suku cadang dengan waktu yang berdistribusi normal dengan: rata-rata = 4 menit, Standar deviasi = 1 menit. Sistem berjalan selama 12 jam. Mesin hanya dapat memproses satu suku cadang pada satu waktu. Jika mesin sedang sibuk, suku cadang yang tiba harus menunggu dalam antrian sebelum diproses.

Tugas:

1. Laporkan rata-rata panjang antrian sebelum mesin
2. Laporkan rata-rata waktu pemrosesan per suku cadang
3. Laporkan jumlah suku cadang yang selesai pada akhir simulasi

Bentuk Simulasi Dan Pendefinisian Pada 'JaamSim'

Struktur Model ("*A small manufacturing system consisting of a conveyor and a processing tool. Raw parts arrive at regular intervals, move along a conveyor, and are processed by a single machine before being sent out of the system.*"):



"*Parts arrive every 5 minutes (deterministic arrival)*":

Input Editor - PartsArrive

Key Inputs | Options | Thresholds | Maintenance | Format | Graphics

Keyword	Default	Value
Name	*None*	PartsArrive
Description	*None*	
NextComponent	*None*	ConveyorTravel
FirstArrivalTime	0.0 h	
InterArrivalTime	2.77777777777...	5 min
EntitiesPerArrival	1	
PrototypeEntity	*None*	Parts
BaseName	*Generator Name*	
MaxNumber	*Infinity*	
InitialNumber	0	

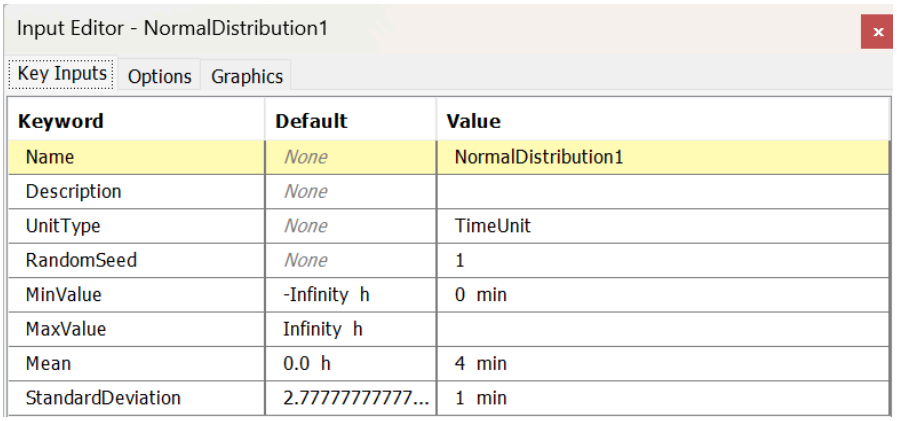
"The conveyor transports each part to the machine; the conveyor travel is 1 minute (deterministic arrival)":

Input Editor - ConveyorTravel

Key Inputs | Options | Thresholds | Maintenance | Format | Graphics

Keyword	Default	Value
Name	*None*	ConveyorTravel
Description	*None*	
NextComponent	*None*	EntityLogger1
TravelTime	0.0 h	1 min
Length	0.0 m	
EntitySpace	0.0 m	
AccumulationLength	0.0 m	
Accumulating	FALSE	
MaxValidNumber	10000	

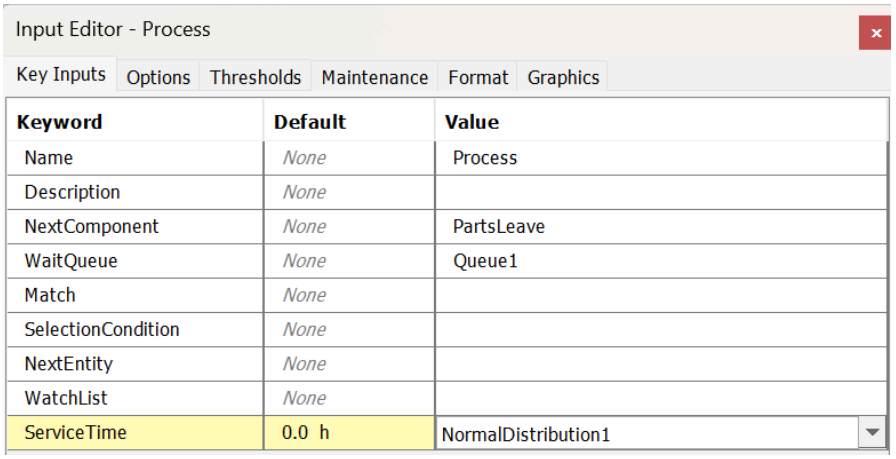
"The machine processes each part for a normally distributed time with: mean = 4 minutes, Standard deviation = 1 minute.":



Input Editor - NormalDistribution1

Key Inputs | Options | Graphics

Keyword	Default	Value
Name	*None*	NormalDistribution1
Description	*None*	
UnitType	*None*	TimeUnit
RandomSeed	*None*	1
MinValue	-Infinity h	0 min
MaxValue	Infinity h	
Mean	0.0 h	4 min
StandardDeviation	2.77777777777...	1 min

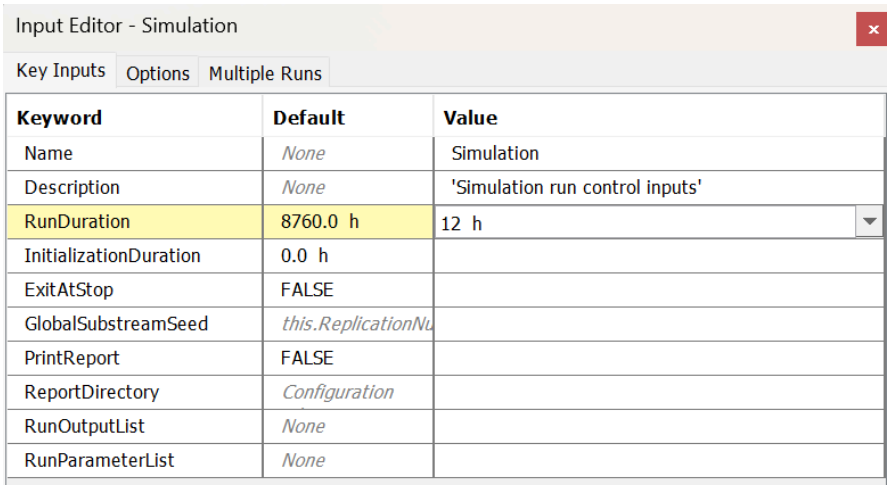


Input Editor - Process

Key Inputs | Options | Thresholds | Maintenance | Format | Graphics

Keyword	Default	Value
Name	*None*	Process
Description	*None*	
NextComponent	*None*	PartsLeave
WaitQueue	*None*	Queue1
Match	*None*	
SelectionCondition	*None*	
NextEntity	*None*	
WatchList	*None*	
ServiceTime	0.0 h	NormalDistribution1

"The system runs for 12 hours.":



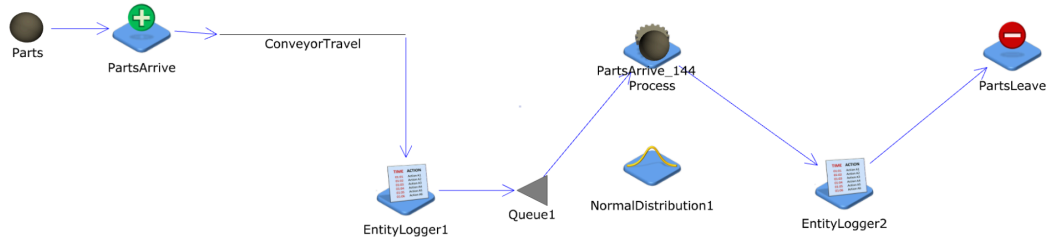
Input Editor - Simulation

Key Inputs | Options | Multiple Runs

Keyword	Default	Value
Name	*None*	Simulation
Description	*None*	'Simulation run control inputs'
RunDuration	8760.0 h	12 h
InitializationDuration	0.0 h	
ExitAtStop	FALSE	
GlobalSubstreamSeed	*this.ReplicationNu*	
PrintReport	FALSE	
ReportDirectory	*Configuration*	
RunOutputList	*None*	
RunParameterList	*None*	

“The machine can only process one part at a time. If the machine is busy, arriving parts must wait in a queue before processing.”:

Conveyor And Processing Problem



1970-Jan-01 12:00:00.000

Pengaturan EntityLogger1 dan EntityLogger2 Untuk Proses Analisa:

Input Editor - EntityLogger1

Key Inputs | Options | Graphics

Keyword	Default	Value
Name	*None*	EntityLogger1
Description	*None*	
DataSource	*None*	{ 'this.SimTime/1[h] * 3600' }
SeparateFiles	FALSE	
IncludeInitialization	TRUE	
StartTime	0.0 h	
EndTime	Infinity h	
NextComponent	*None*	Queue1
TraceEntityStates	FALSE	

Input Editor - EntityLogger2

Key Inputs | Options | Graphics

Keyword	Default	Value
Name	*None*	EntityLogger2
Description	*None*	
DataSource	*None*	{ 'this.SimTime/1[h] * 3600' }
SeparateFiles	FALSE	
IncludeInitialization	TRUE	
StartTime	0.0 h	
EndTime	Infinity h	
NextComponent	*None*	PartsLeave
TraceEntityStates	FALSE	

Laporan Analisa Tugas

1. Report the average queue length before the machine:

Berdasarkan Output Viewer di Queue,

Output Viewer - Queue1

Output	Value
Entity	
Name	"Queue1"
ObjectType	[Queue]
SimTime	12.0000 h
Parent	[Simulation]
Children	{[Queue1.Label]}
Prototype	null
CloneList	{}
DisplayEntity	
Region	null
Position	1.0 -1.4 0.0 [m]
Size	0.5 0.5 0.0 [m]
Orientation	0.0 0.0 0.0 [deg]
Alignment	0.0 0.0 0.0
Show	true
GraphicalLength	0.500000 m
ObserverList	{}
NextList	{[Process]}
PreviousList	{[EntityLogger1]}
EntityReferenceList	{}
StateEntity	
State	"None"
WorkingState	false
WorkingTime	0.00000 h
StateTimes	{"None"=12.0000[h]}
TotalTime	12.0000 h
LinkedComponent	
obj	[PartsArrive_144]
NumberAdded	144
NumberProcessed	144
NumberInProgress	0
ProcessingRate	0.00333333 /s
ReleaseTime	11.9333 h
Queue	
QueueLength	0
QueueList	{}
QueueTimes	{}
PriorityValues	{}
MatchValues	{}
QueueLengthAverage	0.0325939

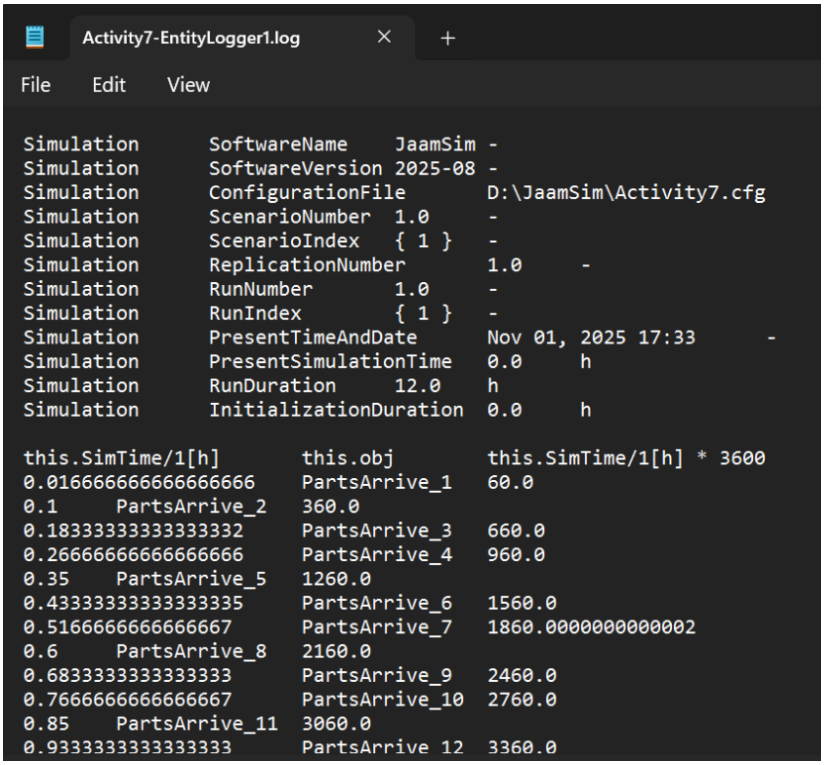
Output Viewer - Queue1

Output	Value
ReleaseTime	11.9333 h
Queue	
QueueLength	0
QueueList	{}
QueueTimes	{}
PriorityValues	{}
MatchValues	{}
QueueLengthAverage	0.0325939
QueueLengthStandardD...	0.177571
QueueLengthMinimum	0
QueueLengthMaximum	1
QueueLengthTimes	{11.6089[h], 0.391127[h]}
QueueLengthFractions	{0.967406, 0.0325939}
QueueLengthCumulativ...	{0.967406, 1.00000}
AverageQueueTime	0.00271616 h
MatchValueCount	0
UniqueMatchValues	{}
MatchValueCountMap	{}
MatchValueMap	{}
NumberReneged	0
QueuePosition	-1
Input Values	
StateAssignment	""
Priority	0
Match	""
RenegeTime	Infinity h
RenegeCondition	1.00000
MaxValidLength	10000
Spacing	0.00000 m
MaxPerLine	Infinity
MaxRows	Infinity

QueueLengthAverage = 0.0325939. Artinya, secara rata-rata, panjang antrian sebelum mesin adalah 0.0325939 part. Nilai yang sangat kecil ini menunjukkan bahwa antrian hampir selalu kosong.

AverageQueueTime = 0.00271616 h. Artinya, secara rata-rata, waktu tunggu setiap part di dalam antrian adalah 0.00271616 jam. Jika dikonversi: 0.00271616 jam * 60 menit = 0.1629696 menit = 9.778176 detik.

Berdasarkan EntityLogger,

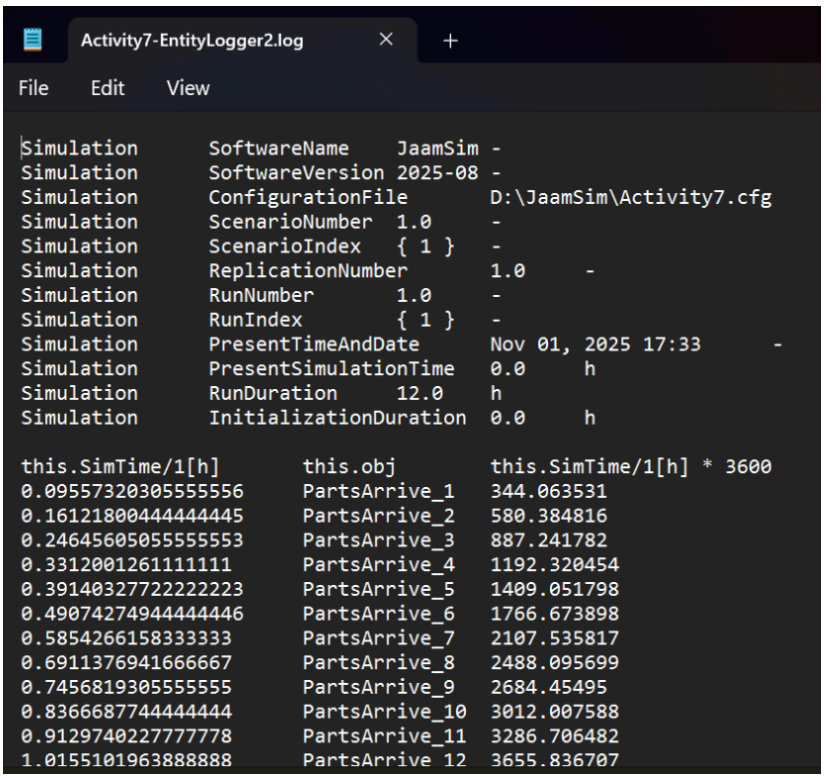


Activity7-EntityLogger1.log

File Edit View

```
Simulation      SoftwareName    JaamSim -
Simulation      SoftwareVersion 2025-08 -
Simulation      ConfigurationFile       D:\JaamSim\Activity7.cfg
Simulation      ScenarioNumber  1.0     -
Simulation      ScenarioIndex   { 1 }   -
Simulation      ReplicationNumber       1.0     -
Simulation      RunNumber       1.0     -
Simulation      RunIndex        { 1 }   -
Simulation      PresentTimeAndDate      Nov 01, 2025 17:33      -
Simulation      PresentSimulationTime   0.0     h
Simulation      RunDuration     12.0    h
Simulation      InitializationDuration  0.0     h

this.SimTime/1[h]       this.obj        this.SimTime/1[h] * 3600
0.016666666666666666    PartsArrive_1   60.0
0.1     PartsArrive_2   360.0
0.18333333333333332     PartsArrive_3   660.0
0.26666666666666666     PartsArrive_4   960.0
0.35    PartsArrive_5   1260.0
0.43333333333333335     PartsArrive_6   1560.0
0.5166666666666667      PartsArrive_7   1860.0000000000002
0.6     PartsArrive_8   2160.0
0.6833333333333333      PartsArrive_9   2460.0
0.7666666666666667      PartsArrive_10  2760.0
0.85    PartsArrive_11  3060.0
0.9333333333333333      PartsArrive_12  3360.0
```



Activity7-EntityLogger2.log

File Edit View

```
Simulation      SoftwareName    JaamSim -
Simulation      SoftwareVersion 2025-08 -
Simulation      ConfigurationFile       D:\JaamSim\Activity7.cfg
Simulation      ScenarioNumber  1.0     -
Simulation      ScenarioIndex   { 1 }   -
Simulation      ReplicationNumber       1.0     -
Simulation      RunNumber       1.0     -
Simulation      RunIndex        { 1 }   -
Simulation      PresentTimeAndDate      Nov 01, 2025 17:33      -
Simulation      PresentSimulationTime   0.0     h
Simulation      RunDuration     12.0    h
Simulation      InitializationDuration  0.0     h

this.SimTime/1[h]       this.obj        this.SimTime/1[h] * 3600
0.09557320305555556     PartsArrive_1   344.063531
0.16121800444444445     PartsArrive_2   580.384816
0.24645605055555553     PartsArrive_3   887.241782
0.3312001261111111      PartsArrive_4   1192.320454
0.39140327722222223     PartsArrive_5   1409.051798
0.49074274944444446     PartsArrive_6   1766.673898
0.5854266158333333      PartsArrive_7   2107.535817
0.6911376941666667      PartsArrive_8   2488.095699
0.7456819305555555      PartsArrive_9   2684.45495
0.8366687744444444      PartsArrive_10  3012.007588
0.9129740227777778      PartsArrive_11  3286.706482
1.0155101963888888      PartsArrive_12  3655.836707
```

Cara Pemrosesan:
Rata-rata Panjang Antrean
Hukum Little: L_q = lambda * W_q
L_q = Rata-rata Panjang Antrean (yang kita cari).
lambda = Rata-rata tingkat kedatangan (part per detik).
W_q = Rata-rata Waktu Tunggu di Antrean (detik per part).
Kita bisa menghitung lambda dan W_q dari log.

Metode (Hitung W_q):
Waktu tunggu (WaktuTunggu) adalah selisih antara kapan part mulai diproses dan kapan part itu tiba di antrean.
WaktuTunggu(n) = T_ProsesMulai(n) - T_TibaAntrean(n)

Menggunakan formula dari Task 2: WaktuTunggu(n) = MAX(T_TibaAntrean(n) , T_ProsesSelesai(n-1)) - T_TibaAntrean(n)

Perhitungan (Contoh):
Untuk Part 1:
T_TibaAntrean(1) = 60.0s
T_ProsesSelesai(0) = 0s
WaktuTunggu(1) = MAX(60.0, 0) - 60.0 = 0s (tidak menunggu)

Untuk Part 9:
T_TibaAntrean(9) = 2460.0s
T_ProsesSelesai(8) = 2488.0957s
WaktuTunggu(9) = MAX(2460.0, 2488.0957) - 2460.0 = 28.0957s (menunggu 28 detik)

Hasil:
Hitung W_q (Rata-rata Waktu Tunggu): Hitung WaktuTunggu(n) untuk semua 144 part yang tiba di antrean (dicatat di EntityLogger1.log). Jumlahkan semuanya, lalu bagi 144.
W_q = SUM(WaktuTunggu(1...144)) / 144
(Hasilnya akan ~9.778177597 detik atau ~0.002716160444 h. Ini sama persis dengan AverageQueueTime).

Hitung lambda (Tingkat Kedatangan): 144 part tiba di EntityLogger1 selama 12 jam (43200 detik).
lambda = 144 part / 43200 detik = 0.00333... part/detik (atau 1 part/300 detik).
Hitung L_q (Rata-rata Panjang Antrean):
L_q = lambda * W_q
L_q = (144 / 43200) * 9.778

Kesimpulan: L_q akan menjadi 0.03259392532 part. Ini sama persis dengan QueueLengthAverage = 0.0325939. Dan Rata-rata Waktu Tunggu ~9.778177597 detik atau ~0.002716160444 h. Ini sama persis dengan AverageQueueTim e= 0.00271616 h.
https://docs.google.com/spreadsheets/d/1W9gLSoASnmQuj6KDUNDlh78TRjbcsCbX/edit?usp=sharing&ouid=102426845364381063047&rtpof=true&sd=true

2. Report the average processing time per part:
Berdasarkan Output Viewer Process:

Output Viewer - Process

Output	Value
Entity	
Name	"Process"
ObjectType	[Server]
SimTime	12.0000 h
Parent	[Simulation]
Children	{[Process.Label]}
Prototype	null
CloneList	{}
DisplayEntity	
Region	null
Position	3.0 1.0 0.0 [m]
Size	1.0 1.0 1.0 [m]
Orientation	0.0 0.0 0.0 [deg]
Alignment	0.0 0.0 0.0
Show	true
GraphicalLength	1.00000 m
ObserverList	{}
NextList	{[EntityLogger2]}
PreviousList	{[Queue1]}
EntityReferenceList	{[EntityLogger2], [Queue1], [NormalDistribution1]}
StateEntity	
State	"Working"
WorkingState	true
WorkingTime	9.42606 h
StateTimes	{"Idle"=2.57394[h], "Working"=9.42606[h]}
TotalTime	12.0000 h
AbstractStateUserEntity	

Output Viewer - Process

Output	Value
AbstractStateUserEntity	
Idle	false
Working	true
Setup	false
Setdown	false
Maintenance	false
Breakdown	false
Stopped	false
Utilisation	0.785505
Commitment	0.785505
Availability	1.00000
Reliability	1.00000
StateUserEntity	
Open	true
NextMaintenanceTime	Infinity h
NextBreakdownTime	Infinity h
LinkedDevice	
obj	[PartsArrive_144]
NumberAdded	144
NumberProcessed	143
NumberInProgress	1
ProcessingRate	0.00331019 /s
ReleaseTime	11.9178 h
LinkedService	
MatchValue	null
ServiceDuration	0.0793997 h
ServicePerformed	0.0666667 h
FractionCompleted	0.839634
Input Values	
StateAssignment	""
Match	""
ServiceTime	0.0793997 h

ServicePerformed = 0.0666667 h. Artinya adalah Waktu Pelayanan (Service Time) atau Waktu Proses murni. Ini adalah rata-rata waktu yang dibutuhkan untuk mengerjakan satu unit. Angka ini tidak termasuk waktu antri. Kalkulasi: 0.0666667 jam* 60 menit/jam = 4.0 menit. (Sesuai Definisi mean = 4 menit).

ServiceDuration = 0.0793997 h. Artinya adalah Waktu Alir (Flow Time) atau Waktu Total di Sistem. Ini adalah rata-rata waktu total yang dihabiskan satu unit di stasiun kerja tersebut, yang mencakup Waktu Antri + Waktu Pelayanan.

Berdasarkan EntityLogger,
Cara Pemrosesan:
Waktu pemrosesan (WaktuProses) adalah waktu part selesai (T_ProsesSelesai) dikurangi waktu part mulai diproses (T_ProsesMulai).

- T_ProsesSelesai(n) ada di EntityLogger2.log (Kolom 3).
- T_TibaAntrean(n) ada di EntityLogger1.log (Kolom 3).
- Sebuah part baru bisa mulai diproses hanya jika part itu sudah tiba dan mesin sudah selesai memproses part sebelumnya (n-1).
- Jadi, T_ProsesMulai(n) = MAX(T_TibaAntrean(n) , T_ProsesSelesai(n-1)).

Perhitungan (Contoh):

- Untuk Part 1:
  - T_TibaAntrean(1) = 60.0s
  - T_ProsesSelesai(0) = 0s (mesin awalnya idle)
  - T_ProsesMulai(1) = MAX(60.0, 0) = 60.0s
  - T_ProsesSelesai(1) = 344.0635s
  - WaktuProses(1) = 344.0635s - 60.0s = 284.0635s
- Untuk Part 2:
  - T_TibaAntrean(2) = 360.0s
  - T_ProsesSelesai(1) = 344.0635s
  - T_ProsesMulai(2) = MAX(360.0, 344.0635) = 360.0s (Part 2 tiba setelah mesin idle, jadi tidak ada antrean).
  - T_ProsesSelesai(2) = 580.3848s
  - WaktuProses(2) = 580.3848s - 360.0s = 220.3848s
- ...
- Untuk Part 9:
  - T_TibaAntrean(9) = 2460.0s
  - T_ProsesSelesai(8) = 2488.0957s
  - T_ProsesMulai(9) = MAX(2460.0, 2488.0957) = 2488.0957s (Part 9 tiba sebelum Part 8 selesai, jadi Part 9 harus menunggu).
  - T_ProsesSelesai(9) = 2684.4549s
  - WaktuProses(9) = 2684.4549s - 2488.0957s = 196.3592s

Hasil: Anda harus melakukan perhitungan ini untuk semua 143 part yang selesai, menjumlahkan semua WaktuProses(n), lalu membaginya dengan 143.
Kesimpulan: SUM(WaktuProses(1...143)) / 143 akan menghasilkan 235.6211826 detik (atau **3.92701971 menit**).
https://docs.google.com/spreadsheets/d/1W9gLSoASnmQuj6KDUNDlh78TRjbcsCbX/edit?usp=sharing&ouid=102426845364381063047&rtpof=true&sd=true

3. Repost the number of parts completed by the end of simulation
Berdasarkan Output Viewer PartsLeave:

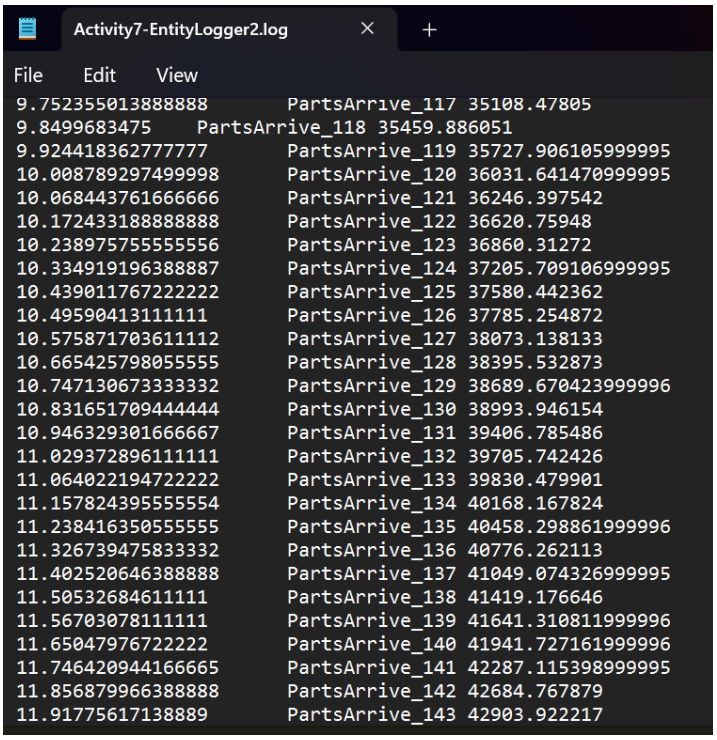
Output Viewer - PartsLeave

Output	Value
Entity	
Name	"PartsLeave"
ObjectType	[EntitySink]
SimTime	12.0000 h
Parent	[Simulation]
Children	{[PartsLeave.Label]}
Prototype	null
CloneList	{}
DisplayEntity	
Region	null
Position	9.0 1.0 0.0 [m]
Size	1.0 1.0 1.0 [m]
Orientation	0.0 0.0 0.0 [deg]
Alignment	0.0 0.0 0.0
Show	true
GraphicalLength	1.00000 m
ObserverList	{}
NextList	{}
PreviousList	{[EntityLogger2]}
EntityReferenceList	{}
StateEntity	
State	"None"
WorkingState	false
WorkingTime	0.00000 h
StateTimes	{"None"=12.0000[h]}
TotalTime	12.0000 h
LinkedComponent	
obj	[PartsArrive_143]
NumberAdded	143
NumberProcessed	143
NumberInProgress	0
ProcessingRate	0.00331019 /s
ReleaseTime	11.9178 h

NumberAdded = 143. Artinya berarti 143 entitas (parts) telah tiba di objek PartsLeave. Jumlah total parts yang telah menyelesaikan semua stasiun kerja dalam model dan sampai di pintu keluar.

NumberProcessed = 143. Artinya berarti 143 entitas (parts) telah dihilangkan dari simulasi oleh objek PartsLeave.

Berdasarkan EntityLogger2,
Cara Pemrosesan:



Hasil: Berdasarkan EntityLogger2, hanya ada terdapat 143 suku cadang yang menyelesaikan proses.
Kesimpulan: Jumlah suku cadang yang selesai pada akhir simulasi ada **143** suku cadang.