Waiting cannot be eliminated completely without incurring inordinate expenses. The goal of queueing theory is to reduce its adverse impact tolerable levels. This does not give you the solution but would give you the measurements or the analysis on your queue.

6 characteristics

A) Input/arrival distribution (inter-arrival) Poisson distribution

B) Output/departure distribution (service)

C) Service channels: the number of servers

D) Service discipline- FCFS, LCFS, SIRO, GD...first come first served, Last Come, First Served, Service in Radom Order. General service Discipline

E) Maximum number of customers allowed in the system...FINITE OR INFINITE

F)Finite or Infinite

Kendall Notation

(a/b/c):(d/e/f)

A for our example is M=Poisson arrival. M stands for Markov

A could also be D, Ek, Gi, G... Deterministic Erlangen, General Independent or just General

Parameters

Area

% area utilization

Max-flow from a deterministic model- max-flow gives the upper-bound of the throughput from a cross-dock and can be used to determine the best shape when the throughput is an integral performance parameter

Throughput from a probabilistic model

Congestion across cross-docks

Unloading Rate

Picking Rate- PR

delivery rate- the rate of delivery of the dock

loading rate- the rate of loading the packages to the outbound truck

travel rate- the rate of transfer of a package from the inbound to outbound dock

All rates are measured and packages per hour

The Mean Value Analysis model calculates the waiting time at each segment of the travel track and the queue length at each junction. The areas, max-flow and throughput from MVA model are all plotted in respective graphs across number of doors to see how cross-dock size affects these parameters for given values of AGV speed (here workers), shape, LR, PR, DR and LR.

Floating dock assignment WMS?

Response time-formulae to calculate the estimated travel times for different types of layouts and for different number of racks in a row or column. Using simulation, they also studied the effect of congestion due to blocking on the travel times. The simulation model showed that increasing the number of vehicles does not affect response time as it significantly reduces the waiting time while increasing the congestion and mean service time. Also, if the pick and place time is large, increasing the number of vehicles leads to higher congestion. In this paper, they also propose an idea of dividing a floor into parts called ‘districts which contain some specified forklifts and service only specified doors and racks. They show with examples that such districting can reduce the response time.

In his Master’s thesis, Athul Gopala Krishna [16] has proposed a queuing model for clearly defined outbound processes in a distribution center and has given results for performance analysis of such a DC for different sizes and workforce utilizations. He developed a generic computational model to calculate travel times for forklifts involved in picking of goods from the racks. The model computes the workforce capacity at different stages of operations to meet specified performance levels using metrics such as truck Processing Time and Labor Hours Per Truck. He also calculates the workforce capacity using Square Root Staffing rule used by call center staffing and finds that the results approximately match. He also uses simulation to validate the results from the mathematical model.

Service rates-the rate in packeges per hour it takes to moves through a part of the CD

Nodes- The nodes are locations from where items are sent or received.

Unloading-A1

Picking-B1, B2

Travel-C1, C2, C3, C4

Delivery-D1, D2, D3, D4

Loading-E1

Arcs- The arcs represent operations in the system or travel in a transportation network. Denote capacity. For our system, capacities of the arcs are the service rates for the operations they represent. A flow network should satisfy the condition that the quantity of flow into a node equals the quantity of flow out of it, except for the source which has only outgoing flow or a sink which has only incoming flow.

THE ARCS HAVE A FINITE CAPACITY

MVA

Closed queueing network of K number of M/M/1 queues and M total customers in the system.

K= a segment?

V-visit ration at a node

L(k)- queue length

W(k)- is the wait time at node k

TH(m)-throughput for a system..m=number of AGV (for us it means workers)

Lk(m)-queue length of segment k in a system with m AGV

=Mean Arrival rate

µ =mean service rate per busy server

=lambda/mu=utilization factor

N-=number of units in the system

Pn(t)=probability of exactly n customers in the system at time t

Pn= probability of exactly n customers in the system

C-number of parallel servers

Ws-expected waiting time per customer in the system

Wq- expected waiting time per customer in the queue

Ls-expected number of customers in the system

Lz-expected number of customers in the queue

LOOK AT QUEUING VS IN SYSTEM







