A REPORT

ON

APPLICATION OF SIMULATION TECHNIQUES IN FUTA BAKEY RAW MATERIAL INVENTORY USING MATLAB

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CHAPTER ONE

1.0 INTRODUCTION

Mathematical models discussed in earlier chapters help decision-makers to choose a *decision alternative*

from the given list of decision alternatives to reach an *optimal solution* to a problem. Simulation that is

not an optimizing technique, helps decision-makers to perform *experiment* with new values of variables and/or parameters in order to understand the changes in the performance or effectiveness of a real system and to make better decision. Such 'experiments' allow to answer '*what if*' questions relating to the effects of changes in the value of variables and/or parameters on the model response. Comparing the payoffs or outcomes due to these changes into the model is referred to as *simulating* the model.

Simulation is a numerical technique for conducting experiments on a digital computer, which involves certain types of mathematical and logical relationships necessary to describe the behavior and structure of a complex real-world system over extended periods of time. (Naylor et al.)
In real life, the customers demand and lead time of goods are uncertainties. The company should have safety stock to feed customers. Statistical data is used to calculate safety stock based on seasonal demand or trend. Poor inventory management leads to wastage of time, impossible to track inventory, increased costs, decreased warehouse organization. Two ways of managing the stock in the Bakery are Stock taking and stock checking.
Purpose of this research is to conduct the detail analysis of the warehouse of FUTA Bakery through simulation method.

1.1 Models of Simulation

Some simulation models are being utilized to simulate real-world scenarios, according to Ekemezie (2015).

These models include heuristic models, which are used to analyze and execute cost-effective processes, as well as to decrease bottlenecks and related hazards.

- Models that are deterministic
- Models that are stochastic
- Models based on algorithms

- Models that are descriptive and adaptive, respectively.

otherwise be obvious due to their temporal separation

Advantages

- ✓ It is simple and straight forward as long as the convergence can be guaranteed by theory
- ✓ Monte Carlo simulation may provide statistical sampling for numerical experiments using computers
- ✓ For optimization problems, Monte Carlo approach can often reach global optimum overcome local extremes
- ✓ It provides approximate solutions to many mathematical problems
- ✓ The method can be used for both stochastic (with probability) and deterministic (without probability) problems

Limitations

It was original developed to study the properties of equilibrium system, it is notuniversally acceptable whether this method can be used to simulate systems that is notin equilibrium

CHAPTER TWO

LITERATURE REVIEW

2.1 Historical Background

The origins of sampling for simulation may be traced back to the 18th century work of George Louis LeClrec and Comte de Buffon. In a number of investigations, these prominent French scientists employed random techniques, the most notable of which is the "Buffon's Needle." It was proven by LeClrec that for a needle the same length as the distance between the lines, the probability of the needle intersecting a line was $2/\pi$, this experiment is considered by most scholars as the first implementation of Monte Carlo simulation method. (Harrison, 2010).
Simulation is the computerized simulation of a system's random behavior with the goal of evaluating its performance metric. (Hamdy A, 2006)

Shannon(1975), opines that simulation is the act of creating a model of a real system and performing experiments with it with the aim of either understanding the system's behavior or assessing potential methods (within the constraints given by a criterion or collection of criteria) for its operation. Simulation models are entities represented by a series of random numbers that are subject to the model's assumptions and are meant to simulate or mimic the behavior of a real system. (Ekemezie, 2015)
Furthermore, simulation is a technique for assessing the performance of a current or prospective system in a variety of configurations and over lengthy periods of time (Anu, 1997). These models are becoming more popular for solving problems and assisting in decision-making. These developments have an impact on consumers, developers, and decision-makers alike. (Sargent, 2009).

2.2 The importance of simulation

Some projects in real life are too dangerous, risky, or costly, and so must be simulated before they are implemented in order to save costs, losses, and ultimately casualties, depending on the kind and size of the project. Simulation modeling, according to Anu (1997), might be used before an existing system is updated or a new system is constructed to decrease the risks of failing to meet requirements, eliminate unanticipated bottlenecks, avoid under or over-utilization of resources, and maximize system performance. Simulation allows you to see the interaction that would otherwise be invisible due to their temporal gap.

2.3 Monte Carlo Simulation

The word Monte Carlo was established in honor of the casino in the Monte Carlo town. Every game at a casino is based on chance, such as a ball landing in a certain spot on a roulette wheel, getting dealt beneficial cards from a randomly shuffled deck, or the dice falling in the correct direction. (Sadus, 2010)

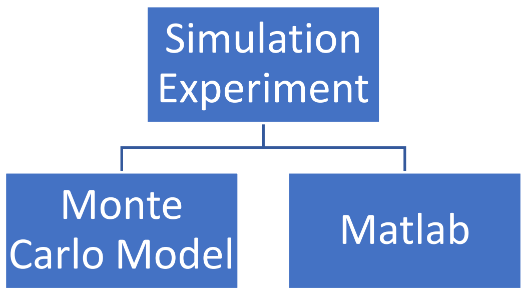
It is a simulation approach that computes the outcomes using repeated random sampling and statistical analysis. This simulation approach is quite similar to random experiments, which are trials where the exact outcome is unknown in advance (Raychaudhuri, 2008)

CHAPTER THREE

3.0 METHODOLOGY

This section reviews the proposed solution methodology for analysing the Federal University of Technology, Bakery flower raw material inventory using simulation technique with monte carlo simulation model.

The two main approach to carry out the analysis of the case study is;



3.1 Case Study

The Federal University of Technology, Akure is considered in this study. The bakery major raw material (flower) inventory is collected for a month.

The information regarding the warehouse resources is recognized and reported. The following data was collected on a monthly basis.

- ✓ Opening Stock
- ✓ Order quantity
- ✓ Re-order level
- ✓ Lead time

S/N	Description	Value/Qty
1	Opening Stock	300
3	Order quantity	300
4	Re-order level	30
5	Lead time	4

Once the data has been recorded simulation model has been built with the use of different modules using MATLAB simulation software. And the model is verified and validated.

3.2 The Monte Carlo Model Steps

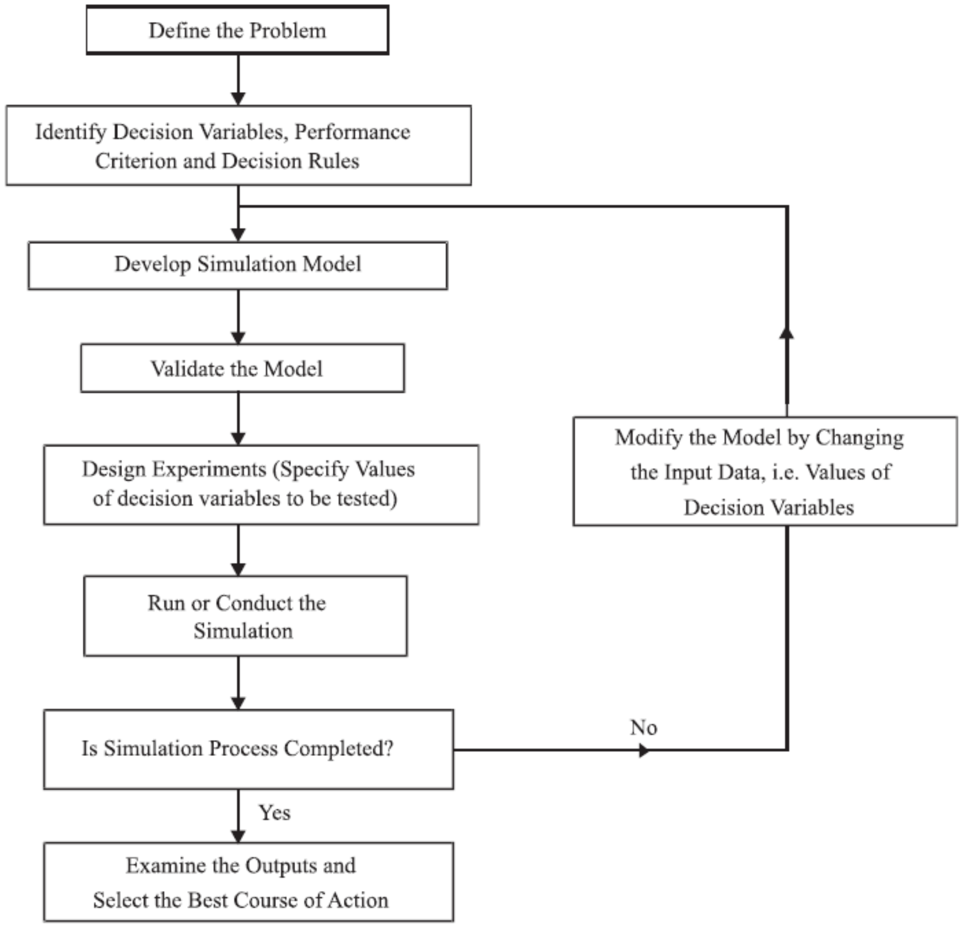


Figure 3.1: The Monte Carlo Simulation Model Flow Chart

3.3 Data Collection

3.3.1 Demand information of a FUTA Bakery is as thus;

Table 2.1: Demand information of FUTA Bakery

S/N	Demand (In Bags of flowers)	Frequency
1	8	2
2	9	5
3	10	13
4	11	7
5	12	3
Total	**30**	

3.4 Demand Probability Table

The demand of the bread in the bakery are certain because the bakery already have almost fixed customers. The stock of flower raw material is usually taken to avoid stock out and meet up with daily demand. There is a lead time of 3 days for stock replenishment. The probabilities of demand are given below:

Each time an order is placed, the bakery incurs an ordering cost.

S/N	Demand (In Bags of flowers)	Probability (Demand/Total)
1	8	0.07
2	9	0.17
3	10	0.43
4	11	0.23
5	12	0.10
Total		**1.00**

Use the sequence of random numbers generated using computer programming to simulate the demand for next 100 days.

Table 3.2: Probability Distribution Table

S/N	*Daily Demand*	*Probability*	*Cumulative*	*Random number lower boundary*	*Random number upper boundary*
1	**8**	0.07	0.07	0	6
2	9	0.17	0.24	7	23
3	10	0.43	0.67	24	66
4	11	0.23	0.9	67	89
5	12	0.1	1	90	99

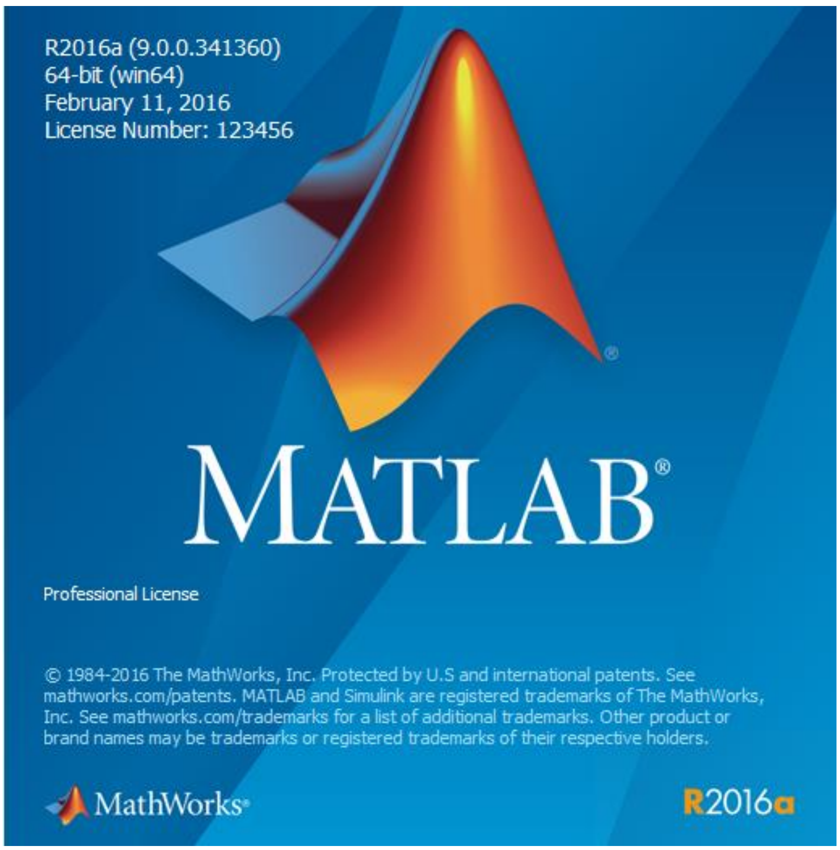
3.4.1 Random Number Generation

Monte Carlo simulation requires the generation of a sequence of random numbers where (i) all numbers are equally likely, and (ii) no patterns appear in sequence of numbers. This sequence of random numbers helps in choosing random observations (samples) from the probability distribution.

3.4.2 Computer generator

The random numbers that are generated by using computer software are uniformly distributed decimal fractions between 0 and 1. The software works on the concept of cumulative *distribution function* for random variables for which we seek to generate random numbers. MATLAB software is used in this case to generate random numbers sampling.

Running the simulation software



```matlab
%MATLAB INVENTORY SIMULATION WITH MATLAB
%ODUMUWAGUN ADEBOWALE AYOMIKUN
%MEE/15/2539

load probtab;
%Given Data

os = 300; % Stock at the beginning of Inventory
LT = 4; % Lead Time
RoL = 30; % Reoder Level
OQ = 300;

% Probability Distribution Table
PDT = probtab;                    % Initialize
PDT(1,3) = probtab(1,2);          % First row of Cumulative Prob.
for j = 1:size(probtab,1)-1       % Other rows of the Cumulative Prob.
    PDT(j+1,3) = PDT(j,3)+ probtab(j+1,2);
end
% Lower limit of the Random Number Interval
PDT(1,4) = 0;
for j = 2:size(probtab,1)
    PDT(j,4) = PDT(j-1,3)*100;
end
% Upper limit of the Random Number Interval
for j = 1:size(probtab,1)
    PDT(j,5) = PDT(j,3)*100-1;
end
```

```
% % SIMULATION EXPERIMENT
% Day Column
Day = (1:100)';

% Random Number Column
RnGen = randi([0 99],100,1);
oo = 0; lt = 0;
for dd = 1:size(Day,1)

% Daily Demand
    for j = 1:size(PDT,1)

        if RnGen(dd,1) > PDT(j,4)-1 && RnGen(dd,1) < PDT(j,5)+1

            Dd(dd,1) = PDT(j,1);

        end

    end
% Opening Stock
if dd ==1
    OS(dd,1) = os;
else
    OS(dd,1) = CS(dd-1,1);
end
% Order Received
if lt > LT
    OR(dd,1) = OQ;
```

```
if lt > LT
    OR(dd,1) = OQ;
    lt = 0;
    oo = 0;
else
    OR(dd,1) = 0;
end
% Closing Stock
CS(dd,1) = OS(dd,1) - Dd(dd,1) + OR(dd,1);
% Order Placement Decision
if CS(dd,1)+oo < RoL
    lt = 1; % Order has just been placed
    oo = OQ;
end

if lt >0
    lt = lt+1;
end
OO(dd,1) = oo;
end

heading = {'Day','Opening Stock','Order Received',...
'Random Number','Daily Demand','Closing Stock',...
'Oustanding Order'};
ggg = [Day OS OR RnGen Dd CS OO];

Table = [heading;num2cell(ggg)];
```

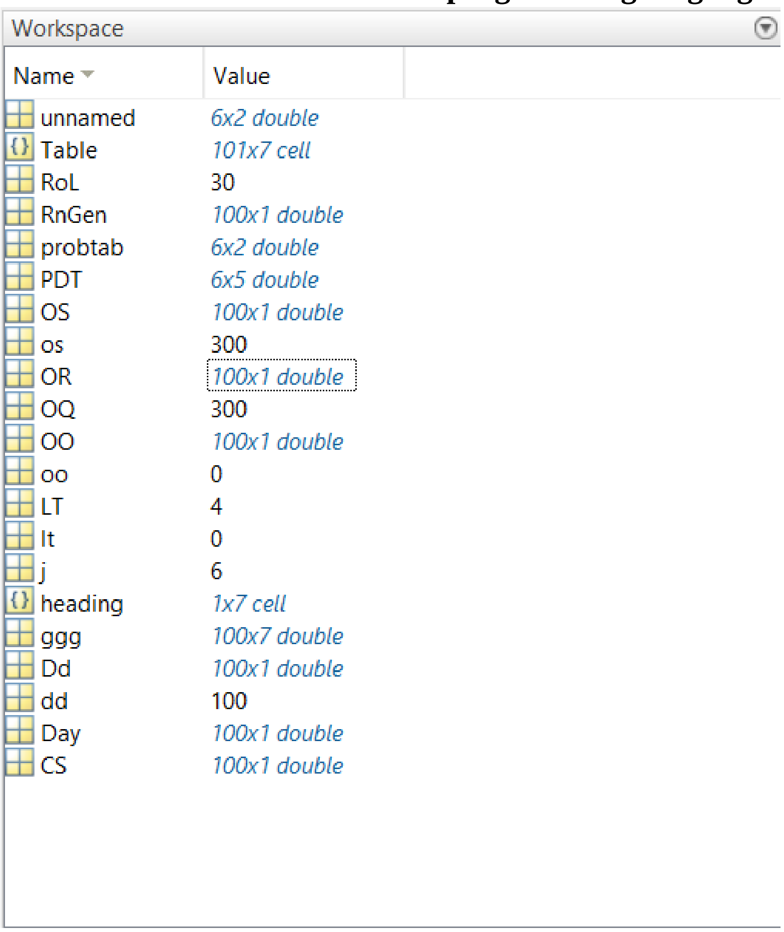
CHAPTER FOUR

4.0 RESULT AND DISCUSSION

Before the result is generated, FUTA Bakery raw material store has been chosen to be a case study for inventory simulation experiment.

Result of the case study

4.1 Result of simulation with programming language



4.2 Final Simulation Experiment Table for next 100 days

'Day'	'Opening Stock'	'Order Received'	'Random Number'	'Daily Demand'	'Closing Stock'	'Outstanding Order'
1	300	0	17	9	291	0
2	291	0	35	10	281	0
3	281	0	5	8	273	0
4	273	0	52	10	263	0

5	263	0	33	10	253	0
6	253	0	17	9	244	0
7	244	0	20	9	235	0
8	235	0	90	12	223	0
9	223	0	67	11	212	0
10	212	0	46	10	202	0
11	202	0	91	12	190	0
12	190	0	10	9	181	0
13	181	0	74	11	170	0
14	170	0	73	11	159	0
15	159	0	56	10	149	0
16	149	0	18	9	140	0
17	140	0	59	10	130	0
18	130	0	29	10	120	0
19	120	0	13	9	111	0
20	111	0	21	9	102	0
21	102	0	89	11	91	0
22	91	0	7	9	82	0
23	82	0	24	10	72	0
24	72	0	5	8	64	0
25	64	0	44	10	54	0
26	54	0	1	8	46	0
27	46	0	89	11	35	0
28	35	0	19	9	26	300
29	26	0	9	9	17	300
30	17	0	30	10	7	300
31	7	0	45	10	-3	300
32	-3	300	10	9	288	0
33	288	0	99	12	276	0
34	276	0	33	10	266	0
35	266	0	29	10	256	0
36	256	0	6	8	248	0

37	248	0	29	10	238	0
38	238	0	4	8	230	0
39	230	0	50	10	220	0
40	220	0	76	11	209	0
41	209	0	63	10	199	0
42	199	0	8	9	190	0
43	190	0	8	9	181	0
44	181	0	77	11	170	0
45	170	0	90	12	158	0
46	158	0	53	10	148	0
47	148	0	10	9	139	0
48	139	0	82	11	128	0
49	128	0	33	10	118	0
50	118	0	29	10	108	0
51	108	0	74	11	97	0
52	97	0	1	8	89	0
53	89	0	4	8	81	0
54	81	0	66	10	71	0
55	71	0	60	10	61	0
56	61	0	52	10	51	0
57	51	0	72	11	40	0
58	40	0	70	11	29	300
59	29	0	78	11	18	300
60	18	0	28	10	8	300
61	8	0	69	11	-3	300
62	-3	300	55	10	287	0
63	287	0	39	10	277	0
64	277	0	6	8	269	0
65	269	0	78	11	258	0
66	258	0	33	10	248	0
67	248	0	60	10	238	0
68	238	0	74	11	227	0

69	227	0	10	9	218	0
70	218	0	12	9	209	0
71	209	0	54	10	199	0
72	199	0	48	10	189	0
73	189	0	89	11	178	0
74	178	0	79	11	167	0
75	167	0	73	11	156	0
76	156	0	5	8	148	0
77	148	0	7	9	139	0
78	139	0	8	9	130	0
79	130	0	79	11	119	0
80	119	0	94	12	107	0
81	107	0	68	11	96	0
82	96	0	13	9	87	0
83	87	0	72	11	76	0
84	76	0	11	9	67	0
85	67	0	11	9	58	0
86	58	0	64	10	48	0
87	48	0	32	10	38	0
88	38	0	65	10	28	300
89	28	0	74	11	17	300
90	17	0	58	10	7	300
91	7	0	74	11	-4	300
92	-4	300	23	9	287	0
93	287	0	73	11	276	0
94	276	0	97	12	264	0
95	264	0	86	11	253	0
96	253	0	8	9	244	0
97	244	0	36	10	234	0
98	234	0	36	10	224	0
99	224	0	68	11	213	0
100	213	0	59	10	203	0

CHAPTER FIVE

5.1 Conclusion

Since the company have a fixed production and demand per day. The simulation was able to randomly generate the data for the bakery flower inventory and forecast for the next 100 day. A month data was collected and simulated using MATLAB to run the simulation experiment thereby, generate random numbers automatically and run the probability table across this random number. The opening stock, closing stock, re-order level, daily demand and outstanding orders are known for the next 100 days. This simulation was able to generate a forecast data for the next 3 months for FUTA Bakery.

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APPENDIX

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      if RnGen(dd,1) > PDT(j,4)-1 && RnGen(dd,1) < PDT(j,5)+1

         Dd(dd,1) = PDT(j,1);

      end

   end
% Opening Stock
if dd ==1
   OS(dd,1) = os;
else
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% Order Received
if lt > LT
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% Closing Stock
CS(dd,1) = OS(dd,1) - Dd(dd,1) + OR(dd,1);
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    oo = OQ;
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