

Simulating Demand for Rice in Owode Market, Offa L.G.A. Kwara State

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Abstract

Estimating the optimal weekly demand (purchase) of rice in any market is one of the fundamental tasks in determining how much product should be purchased weekly and the expected value. Rice, one of the foods consumed which used to be a food of the highly privileged one before but occasionally consumed during important festivals by the less privileged ones some years ago has become a stable food that is consumed by almost all the households in Nigeria today. Its consumption is so high to the extent that the locally produced ones cannot meet the demand of the teeming population. Reports have it that the country spent a lot of its hard earned foreign reserves to import rice in order to meet the increasing domestic demands for it. Nigeria consumes 5.4 million MT of rice annually with #600 billions of which 1.6 Million MTS are imported. Nigeria is the largest importation of rice in the world, buying at least 2 million metric tones per year from exporting countries like China and Thailand, yet Nigeria fertile land and rich agro climate conditions could easily produce rice to feed the entire country and generate surplus for the region (USAID). According to This Day News Paper of 17th December, 2012, the Federal Government disclosed that \$150 billion will be spent to meet Nigerians annual demand by 2050. The amount spent has been so colossal and alarming that there is a need to stimulate the demand for rice over certain periods of time to confirm the government assertion and claims, hence, this study. Specifically, the objectives of this paper are to generate a demand pattern for 25 weeks in Owode market, Offa Local Government, Kwara State, and estimate optimal weekly demand for rice and determine the expected value. The analytical tool used in this study is Monte-Carlo simulation model. Findings revealed that on the average, 523.6 bags of rice were demanded per week, and the expected value puts at 521.9 bags. The paper recommends and concludes that drastic and urgent action should be taken by the government to encourage locally produced rice in order to save the country from spending so much foreign reserves on importation of rice.

Key words: Demand, Simulation, Monte-Carlo, Steady State.

1. Introduction

To simulate is to imitate. In general terms, simulation involves developing a model of some real phenomenon and then performing experiments on the model evolved. It is a descriptive and not optimizing technique. In simulation, a given system is copied and the variables and constants associated with it are manipulated in that artificial environment to examine the behaviour of the system (Vohra 2006).

A simulation model may be a physical mathematical model, a mental conception, or a combination. Many simulations involve physical model.

For the real life queuing systems, assumptions that the arrivals of customers are Poisson distributed while the service time follows an exponential distribution are often appropriate. Thus, where such assumption fails to apply, formal mathematical analysis can be extremely difficult and even impossible. Certain real word problems may be

amendable to analytical solution. The complexity may arise from stochastic form of the model parameters, inability to specific concise by the logical relationship between the various parts of the model. For such problems, the concept of optimality is out of the way. An alternative method is simulation. In simulation, several measures of performance of the complex system are generated before conducting sampling experiment based on a mathematical model of the system overtime. Hence, the result of the simulation can only approximate the population solution after very many experiments. So in simulation, there is trade of between accuracy and cost.

Simulation is an experimental tool that can be used when decision problems have complex variables such as controllable and uncontrollable random events as well as dynamic phenomenon in the model parameters (Adedayo et al, 2006). Simulation models are not deterministic. They deal mainly with imitations of reality and are descriptive in nature. These models describe the problems investigated instead of finding solution to the problems.

Simulation models can be used to estimate the demand for a product knowing the demand per day or per week of a particular product if the product is a discrete random variable in case of rice and random variable defined by a particular probability distribution once the random numbers have been chosen. What is required is to generate demand pattern for any giving period.

Davis and Bayer (1986) asserted that arrival and service times are generally not known with certainty but are stochastic, or probability in nature. Arrival and service times must be described by the probability distributions. Customers into the market arrived in random manners. Occurrences that can be said to have no memory of past events. There are different types of simulation. But for the purpose of this study, probability simulation is going to be used. This is because uncertainty occurs in everyday life and there is need to take the randomness into account in this model. Arrival of customers into the market to demand for a product is always random, and demand for the product is also random variable. Monte-Carlo process involves obtaining random values for the random variables. There are so many reasons for using simulation in analyzing operations management problems. Simulation models can be used to conduct experiment without disrupting real system. It could also be used to obtain operating characteristic estimates in much less time than is required to gather the same operating data from a real system.

The general objective of this paper therefore is to confirm the government assertion and claims that demand for rice consumption has been on the increase. This study specifically aims:

- to determine the demand/week of rice
- to generate a demand pattern for 25 weeks
- to estimate average simulated demand/per week
- to determine the expected value
- to suggest appropriate policy measure to address the trend.

2. Literature Review

Demand for rice is like demand for any product in the market. Demand in economics is the desire to possess something and the willingness and the ability to pay a certain price in order to possess it (Harvey 1983). In order words, it is not merely a wish or a desire but an effective demand i.e. desire backed by money. It refers specifically to how much of a good person would actually be willing to buy at a given price over a period of time.

The amount of commodity that households wish to purchase is called the quantity demanded of that commodity (Lipsey 1979). He opined that two important things must be known about the quantity demanded. First, it is a desired quantity. It is how much they actually succeed in purchasing. If a sufficient quantity is not available, the amount households wish to purchase may exceed the amount that they do purchase. The second thing to note is that quantity demanded is a flow. The concerned is not with a single isolated purchase, but with a continuous flow of purchases, and we must therefore express demands as so much per period of time-one million oranges per day, say, or seven million oranges per week, or 365 million per year.

Handson (1976) defined demand as the quantity demanded at a particular price, for it is impossible to conceive of demand not related to price. Sometimes the term effective demand is used to distinguish demand from need. For the economist, demand is always effective demand, i.e. the desire to buy must be coupled with the ability to pay (Taylor 1980). Speaking in the same vein, David Anderson (1980) posited that it is essential that demand is not confused with simply “wanting” something. According to him, it has to be backed up with the ability to pay the price. Thus, demand is the quantity of a commodity that would be bought at a price, over a period of time. It is meaningless to talk of demand without stating the price. The period of time is also important, demand is a flow, and clearly more is likely to be brought in a year than in a month, so the time must be stated.

According to David Begg et al (1984), demand is the quantity of a good buyer wish to purchase at each conceivable price. Demand is the quantity of a commodity that consumers are willing and able to buy at a given price at a time (Paul Kofi Tawiah 1984). He goes further by saying that demand is different from want in the sense that demand is from want in the sense that demand is always by willingness and ability to buy a commodity at a price within a period of time. This according to him is also called effective demand.

Simulation is used when service system is not in a steady state. According to Cooper (1972), a steady state is a service system characterized by the following:

Constant number of services, average arrival and service rates over a long period of time.

The average arrival rate is less than the average service rate times the number of servers.

That (i.) and (ii.) hold for a reasonable long period of time.

From Cooper's position, one can state that in order to achieve steady state, the effective arrival rate of customers must be less than the sum of the effective service rate of all servers. Lawrence et al (2002) stated the following requirements to achieve steady state.

System with one server $\lambda < \mu$

System with K servers, possible with different service rates - $\lambda < \mu_1 + \mu_2 + \dots + \mu_k$

System with K servers, each with service rate $\lambda < k \mu$

With respect to how customers arrived the market and how they were served, the above conditions were satisfied.

Simulation or rough-cut analysis is the act of reproducing the behaviour of a system using a model that describes the operations of the system. Using a simulation model, the analyst actually generates customer arrivals, put customers into waiting lines, and selects the next customer to be served by using some priority discipline, serves that customer, and so on. The model keeps track of the number in line, waiting time, and the like during the simulation and calculates the averages and variances at the end. Simulation is useful in sharpening management decision-making skills through gaming. A descriptive model that relates managerial decisions to important operating characteristics (such as profits, market share, and the like) can be developed.

To simulate is to duplicate the dynamic behaviour of the essential characteristics of a system, operation, or process overtime without attaining reality (Daellebach and George 1978).

3. Simulation Method

Stafford (1979) observed that when problems become too complex for ready solution by analytical methods, one way of proceeding is to set up a simulation model, a model that will behave like the system under observation. Discussing further, he revealed that since many of the system with which we are concerned involve probabilistic or even random elements, any model which we set up to stimulate the real system must also contain random elements. He concludes that because of this "gambling" element, these are often called "Monte-Carlo" models.

Simulation is a theoretical and an expensive alternative to solving queue problem. It is useful when the service system is not in a steady state. According to Levin et al (1986), simulation approach takes off from the incapacities of the traditional queuing model. It shows that the analytical method is simple and cost effective.

Chase and Aquilano (1985) opined that some waiting line problems seem very simple on first impression but later turn out to be extremely difficult or impossible to solve. According to them when a series of activities is performed in sequence where the output rate of one becomes the input rate of the next, then we can no longer use the simple formula. The technique best suited to solving this type of problem is computer simulation.

Simulation Process

Certain steps are involved in the simulation process.

Shannon (1975) presents the simulation process as follow:

Define the System

Formulate a required model

Identify and collect relevant data

(iv) Test the model formulated in (2)

(v) Run the simulation

(vi) Analyze result and if necessary change solution being assessed

(vii) Re run simulation to test new solution

(viii) Validate the simulation

Lawrence and Pasternak (2002) asserted that the approach to simulation analysis is quite similar to that of a general management science process. The key steps in the according to them are;

Defining the problem

Developing the simulation model

Running the simulation model and obtaining Results

Communication the results

Vohra (2006) identified four processes of the simulation process. They:

definition of the problem and statement of objectives

construction of appropriate model

experimentation with the model constructed; and

evaluation of the result of simulation

3.1 Applications of Simulation

Vohra (2007) asserted that simulation is very potent, flexible, and therefore, a commonly employed quantitative tool for solving decision problems. It has been applied successfully to a broad spectrum of problems. He enumerated the following areas of its applications.

Police dispatching

Evaluation of operating alternatives at airports

In financial planning – both portfolios selection and capital budgeting

Scheduling the production processes

Large scale military battles as well as individual weapons systems for aiding in the designing of both the weapon systems and the strategic and tactical operations.

3.2 Advantages of Simulation Analysis

According to Lawrence and Pasternak (2002), simulation as analysis tool has several important advantages and disadvantages. The following has been given as some of the principle advantages:

Simulation provides insight into the problem solution when other management science methods fail.

Simulation enables the performance of an existing system under a proposed set of modifications to be analyzed without disturbing current system performance. Such performance may be analyzed over any time horizon.

Simulation models assist in the design of proposed system by providing a covenant experimental laboratory for conducting “what if” analysis.

4. Methodology

This study utilized statistical sampling procedures because the Local Government does not have readily available data on demand for rice in Owode market. The developed method consists of random selection of demand made by customers over a period of twelve weeks. This is done with the help of research assistants, Owode market is selected because it is one of the biggest markets in Kwara State, Nigeria.

The market is patronized by many states, particularly from the south west of the country and some few states in the Middle Belt–Kogi, and Niger States. The market opens every day but attracts more customers on market day which comes up on every five days of the week. The model used in this study is Monte-Carlo simulation model. The approach is to generate demand for rice for twelve weeks, with associated probability. Cumulative probability function was developed and the range of random numbers determined. The random numbers were then used to generate simulated result.

TABLE 1

DATA PRESENTATION, ANALYSIS AND DISCUSSION.

SUMMARY OF DATA COLLECTED ON DEMAND FOR RICE FOR TWELVE WEEKS

WEEKS	DEMAND (RICE)	PROBABILITY
1.	500	0.08
2.	520	0.08
3.	450	0.07
4.	700	0.11
5.	630	0.10
6.	480	0.07
7.	510	0.08
8.	412	0.07
9.	507	0.08
10.	620	0.10
11.	440	0.07
12.	460	0.07

Source: *Market survey and Researcher's computation (2013).*

TABLE 2

DEMAND OF RICE RANDOM NUMBER FOR TWENTY-FIVE WEEKS

WEEKS	RANDOM NUMBER
1	36
2	50
3	28
4	65
5	49
6	18
7	39
8	68
9	30
10	80
11	95
12	70
13	54
14	36
15	85
16	45
17	96
18	62
19	88
20	76
21	22
22	10
23	42
24	63
25	55

Source: *Market survey and Researcher's computation (2013).*

TABLE 3

CUMULATIVE PROBABILITY FUNCTION (CPF) AND RANGE OF RANDOM NUMBER

DEMAND /WEEK	P(X)	C P F	RANGE OF RANDOM NUMBER
500	0.08	0.08	00 - 07
520	0.08	0.16	08 – 15
450	0.07	0.23	16 – 22
700	0.11	0.34	23 – 33
630	0.10	0.44	34 – 43
480	0.07	0.51	44 - 50
510	0.08	0.59	51 - 58
412	0.07	0.66	59 - 65
507	0.08	0.74	66 - 73
620	0.10	0.84	74 - 83
440	0.07	0.91	84 – 90
460	0.07	0.98	91 - 97

Source: *Researcher's Computation (2013).*

TABLE 4

TWENTY – FIVE WEEKS SIMULATION OF RICE

WEEK	RANDOM NUMBER	SIMULATED DEMAND
1	36	630
2	50	480
3	28	700
4	65	412
5	49	480
6	18	450
7	39	630
8	68	507
9	30	700
10	80	620
11	95	460

12	70	507
13	54	510
14	36	630
15	85	440
16	45	480
17	96	460
18	62	412
19	88	440
20	76	620
21	22	450
22	10	520
23	42	630
24	63	412
25	55	510
		13,090

Source: *Researcher's Computation (2013)*.

In table 4 above, since each number between 00 and 97 has an equal likelihood of being selected, the probability of anyone number being selected is $i/100$. Hence, if 10 of the numbers are assigned to the event “daily demand=0”, this event will occur with a probability of 10. If 36 are assigned to the event, this event will occur with a probability of 36 and so on.

Average simulated demand is

$$\frac{13,090}{25} = 523.6$$

The above implies that on the average, 523.6 bags of rice are demanded per week.

Expected Value of this demand is $(E V) = \sum p_i x_i$
 $= .08 \times 500 + .08 \times 520 + .07 \times 450 + .11 \times 700 + .10 \times 630 + .07 \times 480 + .08 \times 510 + .07 \times 412 + .08 \times 507 + .10 \times 620 + .07 \times 440 + .07 \times 460 = 521.9$

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5. Conclusion and Recommendation

This paper uses the example of demand for rice in Owode market, Offa Local Government, Kwara State, Nigeria to discuss how the analytical tool of Monte-Carlo simulation could provide a greater understanding of the concern of the government towards the demand of rice in Nigeria. The use of this model using Owode market would help to confirm and ascertain the government fear that by 2050, \$150 billion will be spent to meet Nigerians annual rice demand. The demand for rice has been on the increase in the last decades in Nigeria so much that it has gulped a very substantial proportion of the nation's hard earned foreign reserve. As shown by the report of the USAID, Nigeria consumes 5.4 million MT of rice annually with #600 billion of which 1.5 million MTs are imported. The

unfortunate situation however is that, Nigeria has fertile land and agro climate conditions that could easily produce rice to feed the entire country and generate surplus for the region. The study will at least provide a collaborative strategy that could be employed to address the alarming trend before it gets out of hand. The paper simulates demand for rice in one market for a period of twenty-five weeks. The pattern that emerged from one market if aggregated becomes a matter of serious concern. In the light of the picture that emerges from this study, it is recommended that urgent action should be taken through public private participation in Local production of rice in Nigeria.

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