



Developing a Fuzzy-Simulink Model for Mobile Number Portability (MNP)

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Abstract:

Poor quality of service has become a major setback to the mobile telecommunication companies in Nigeria. This has led to customer's complaints and dissatisfaction with the service. Call dropping, higher cost to business and social relationships and call delays are some of the other complaints that have been raised by some mobile phone users. Thus, the need to address the issues raised by the subscribers. This research presents a Fuzzy-Simulink model for MNP. The average QoS KPI's data set for the two prominent mobile network operators (MTN and GLO) in Nigeria from June 2022 to December 2022 was used as a data set for the simulation in MATLAB. ABA (ABIA STATE), UMUAHIA (ABIA STATE) and MBAISE (IMO STATE) were the study areas. From the results, it was seen that the model was able to accommodate the various parameters needed for subscribers to port from one network to another. In the months of June 2022 to December 2022, GLO NG produces the best expectation curve of 96.1% at its peak. It could also be seen that the different networks have different call volumes. The NCC took the lead with 102%, followed by MTN with 101.1% and GLO with 100.9%. The NCC service level was the best, at a peak of 99.91%. The improved service level might be a result of improved service quality. These may include enhanced radio coverage, reduction of radio interface between subscribers, perfections in the functioning of the network, such as improved handover or cell-reselection attempts, efficient loading of the different elements of the network, etc. MTN has the best MNP rate in the months under consideration. The implementation of this work therefore becomes inevitable since the research did not only assess the viability of MNP in Nigeria; it also evaluated the different frameworks as adopted in Nigeria. The model developed in this research will be of immense assistance should the Nigerian Communication Commission decide to revisit mobile number portability as earlier promised from the available literature.

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1.0 Introduction

Nigeria is understood to be on the path of becoming among the major telecommunications markets on earth. Her subscriber base is estimated at about 148.3 million (NCC, 2017). The subscriber stand is in permanent raise and that area has delivered high gains on investments yearly. Telecommunication industries in Nigeria contribute about 9.1% Gross Domestic Products (GDP) of the country (NBS, 2017).

Data from the International Telecommunication Union (ITU) shows that in 2016, the access rate of cellular phone users were 97.1 for every 100 residents worldwide. The information also propose that there are more cell phone subscribers in the developing world than in the civilized world (ITU, 2018). Also, studies indicate that even with the exponential development in technology, processing power, and breakthroughs in IT and reductions in costs. IT projects have continued to fail to achieve time budget and deliverable goals (Matloub *et al.*, 2017). Mobile network service providers charge different tariffs for services provided to their subscribers, which depend on the package(s) a customer subscribes to. For instance, MTN has packages for tariffs ranging from supersaver, mtn zone, family and friends, beta talk, weekends super talk, free night call, xtra value, awu4u, prestige, xtra special post-paid, pulse, start pack, diamond yellow, true talk, xtra pro, ipulse and specific tariffs for internet users. GLOBACOM packages for tariff include infinito, bounce, overload, twin bash, free night calls and family and friends and specific charges for data users. ETISALAT has packages for tariffs ranging from easy starta, easy life, easy cliq, easy flexi, talk zone and different charges for data subscribers. AIRTEL also has packages for tariffs ranging

from smart value, smart connect, smart talk, smart trybe, smart trybe junior, premier and each data user is charged differently (Odunaike, 2019). On each of these packages, the charges for calls, messages, and internet services differ. There is no permanent package on any network. New packages are designed almost on a monthly basis which makes tariff charges by service providers more competitive and this forces down tariff charges. The flexibility of tariff charges by service providers due to the competitive market could have an effect on customer satisfaction and the performance of GSM service providers.

Mobile Number Portability (MNP) is one such technology that can bring call tariff transparency, better competition and lesser charge on phone calls and inter-communication link rate, which could have effects on the usage, inexpensiveness, on line link of cellular phone provisions for subscribers and consequences on the gain border (Smura, 2019). Mobile Number Portability (MNP) can be defined as the capability of cellular phone users to toggle among network providers while maintaining their cellular phone numbers. The switching cost will be minimal since the subscribers have the right to retain their numbers. As a result, the subscribers are challenged with migrating expenses that came with informing public about changing their cellular phone numbers, redesigning their company headed letters, and being unreachable to important calls from the populace that do not have their new cellular phone numbers, etc., (Rajeevet *al.*, 2018).

The aim of this research is to develop a Fuzzy-Simulink based network portability suite model for the two prominent cellular Network operators in Nigeria (MTN and GLO). The two network operators were selected for this research because

both of them counted the largest subscription base with more than 250 million out of 301 million subscriptions in Nigeria.

2.0 Mobile Number Portability in Nigeria

The Nigeria Communications Commission (NCC) on April, 22nd 2013 launched the take-off of the Mobile Number Portability (MNP) scheme, (Adekunle, 2016). The aim of this innovative mission is to foster healthy and unreserved competition within the telecommunication industries in order to bring enhanced and affordable services to the customers. This scheme was well welcomed by the teaming Nigerian populace with full excitement and high expectations. It took the programme three years to kickoff after 2009. The programme is adjourned a new turnaround in the telecommunication sector in Nigeria as it will allow the customers to migrate from one network to the while still retaining their phone numbers at no cost (Ajay and Vijay, 2018). This initiative was targeted at the network operators to sit up or risk losing their esteemed customers. But as an evolving strategy, the essence of the implementation is yet to be fully felt by the network users. Also, the operators of these networks are yet to show commitments in using the MNP implementation to expand their services in the areas of network coverage, quality of services provided, promotions and adverts, as well as drop calls. Despite that, the merits in deployment of MNP in the telecom sector in the country to bring about healthy and efficient competition can never be overestimated.

In his view, Xavier, (2017) highlighted the essence of MNP to the growth and existence of the telecommunication sector of any country. Authors in Tiamiyu and Mejabi, (2018) considered the behaviour of the GSM users on the deployment of mobile number portability (MNP) in Nigeria.

Findings shows that some mobile customers embraced the deployment of MNP in Nigeria, while a good number are of the opinion that implementing MNP when power problems have not been fixed will not make the tariff rate to reduce. Also, it was equally discovered that some demographic influences such as age contributed strongly to the attitude of the customers in accepting MNP in Nigeria (Adeiza, 2019). Based on the above observations, it was advised and recommended that subsequent research works should find experimentally the understanding of MNP as regards to the customers in Nigeria and find out the respondents' intention to port.

Authors in Ajit *et al.* (2018) identified basically three (3) types of MNP being deployed all over the universe today. These include: (a) Location portability (LP), (b) Service Portability (SP) and (c) Service provider portability (SPP).

Location portability: In this type of MNP, the customers retain their mobile phone numbers when migrating from one physical point to the other within the same calling points.

Service Portability: In this type of MNP, the customers retain their mobile phone numbers as they migrate from mobile to fixed service or from Public Switched Telephone Network (PSTN) to Integrated Services Digital Network (ISDN) services.

Service Provider Portability (SPP): Service Provider Portability is the most popular implemented MNP type among all. This type of MNP allows the subscribers to retain their telephones numbers when migrating from one service providers to the other. Service provider portability can be introduced in three ways: geographic, mobile and non-geographic (Aydin, 2020).

2.1. Challenges with Regards to the Implementation of MNP

The deployment of MNP globally was expected to spur healthy competition in the mobile market. Other factors which would determine competition included decrease in mobile tariffs and increase in the mobile related usage, improvement in customer service and satisfaction, differentiation in innovation in mobile packages and value-added services, introduction of new technology and ease of market entry for new respondents (Ajzen, 2018).

The Infocom Development Authority of Singapore (IDA) reviewed the costs for MNP switching. They found that recurring monthly charges for porting incurred by consumers was a hindrance for those wishing to port. Moreover, such costs impacted negatively on the welfare of consumers and competition in the market. IDA subsequently instructed all operators to cease monthly recurring charges but was allowed to charge a once off amount. This decision was regarded as a potential boost for consumer benefit and also a tool for competition growth. It was further established that porting was only limited to post-paid, but that decision was cancelled to include pre-paid as well, thus increasing porting (IDA, 2017). The National Economic Research Associates (NERA) conducted a study which was used as a benchmark for most of academic research on the impact of MNP.

Experiences differed according to countries. On the negative side, porting in Germany took 31 days to be completed. In Italy, only 3, 68% of subscribers ported their numbers a year after MNP was introduced in a country of 95% subscriber base of mobile telephony. In the US, there was a delay with regard to the introduction of MNP because of resistance by mobile operators to launch. Hong Kong reported positive effects on MNP as operators embraced the MNP facility and porting processes were effectively

implemented (NERA, 2017). A survey on MNP was conducted before to the deployment of MNP in South Africa. The purpose was to determine the level of awareness on MNP and further to establish if it would have a positive impact. Interviewees were segmented according to age, gender and level of income in this case, high earners. During the ex-ante assessment which is described as a study that takes place before the fact respondents indicated their willingness to port their numbers after the implementation of MNP. The study further dealt with both merits and demerits of MNP.

The disadvantages include networking locking where operators lock the SIM card to avoid easy access to other operator's network, network prefix identification, which is described as the first three numbers such as (082, 083 or 084) and implementation costs which are costs incurred by operators but passed on to consumers. Three advantages were expected to be in place for consumers: choice, lower prices and better services, (Goldstuck, 2016).

3.0 Methodology

3.1 Developing a Portability Model

Using the performances Key Performance Index (KPI's) of the cellular networks in Nigeria, it is necessary to develop a portability model. The essence of this is to analyze the various KPI's of the Nigeria wireless communication system and also lead the way to enhancing portability. Each of parameters considered by customers will be modelled based on the key performance indicator and a sum score will be used to rate each of the considered parameters.

3.1.1 Customer Services

a. Occupancy Rate (O_r)

Occupancy Rate measures the time call centre agents spend engaging customers on live calls

and doing administration tasks related to those calls. This is given as shown in equations 1 and 2:

$$O_r = T_{hl}/T_l \quad (1)$$

$$T_l = T_{hl} + T_a \quad (2)$$

where, O_r is the occupancy rate, T_{hl} is the total call handling time, T_l is the total logged in time and T_a is the time awaiting agent to pick up call

b. Agent Attrition Rate (A_{ar})

This metric shows the pace at which a call centre's agents resign or retire. High agent attrition rates erode a call centre's ability to serve its customers adequately. The rate is given as shown in equation 3:

$$A_{ar} = N_o/N_a \quad (3)$$

where A_{ar} is the Agent Attrition Rate, N_o is number of employees that left during a given period while N_a is Average number of employees for the Period.

c. Agent Utilization Rate (A_{ur})

Agent Utilization Rate is the average amount of time an agent spends handling calls in a given period relative to the total number of work hours, this performance indicator is given as shown in equation 4:

$$A_{ur} = (N_{hc} \times T_{hl} \text{ (hr)}) / (T_{wh} \text{ (hr)}) \quad (4)$$

where A_{ur} is the Agent Utilization Rate, N_{hc} is Average Number of Handled Calls, and T_{wh} is the Total Work Hours in a given period or paid hours. Like Adherence to Schedule, this metric is also considered a good indicator of agent performance.

d. Adherence to Schedule (A_{ts})

This metric indicates how much an agent spends her time handling customer calls. A low schedule

adherence score contributes to an increase in missed and abandoned Call rates. These, in turn, can negatively impact customer satisfaction and Net Promoter Scores. This is calculated as shown in equation 5:

$$A_{ts} = (T_{hl} + T_{at}) / T_{wh} \quad (5)$$

where A_{ts} is the Adherence to Schedule, T_{hl} is the total call handling time, T_{wh} is the total paid hour and T_{at} is the net available time.

3.1.2 Tariff Plan

a. Cost per Call (CPC)

CPC refers to the average cost incurred by a contact centre for each call it handles. This metric shows how much it costs a call centre to run its operations. It also gives insight on whether a call centre is operating cost-efficiently and allocating its resources well. CPC is calculated as shown in equation 6.

$$C_{pc} = C_c / N_c \quad (6)$$

where C_{pc} is Cost per Call, C_c is Total Cost of All Calls and N_c is the Total Number of Calls

3.1.3 Network Coverage/Performance

a. Call Set Up Success Rate (C_{sr})

This is the ratio of the number of successful seizures of Standalone Dedicated Congestion Channel (SDCCH) to the total number of requests of seizure. Call set up success rate is given as shown in equation 7.

$$C_{sr} = N_{sz} / N_{RZ} \quad (7)$$

where C_{sr} is the Call set up success rate, N_{sz} is the number of successful seizures of SDCCH, N_{RZ} is the total number of requests of seizure.

b. Call Drop Rate (C_{dr})

This metrics determines the rate of calls that was not successfully complete. It is given as shown in equation 8.

$$C_{dr} = \frac{[TCH]_{a}}{[TCH]_{b}} \quad (8)$$

where C_{dr} is the Call Drop Rate, $[TCH]_{b}$ is the channel drop rate after assignment, and $[TCH]_{a}$ is the channel drop rate before assignment.

c. Rate of Successful Handover (H_{sr})

This metrics defines the rate of successful handover calls. It is given as shown in equation 9.

$$[H]_{sr} = N_{sr}/T_{hr} \quad (9)$$

where H_{sr} , is the rate of successful handover, N_{sr} = intracell + intercell hand over and T_{hr} is the total number of handover request.

d. Call Completion Rate (C_{cr})

This defines the rate of successful completion of incoming and outgoing calls. This index is calculated as shown in equation 10.

$$C_{cr} = C_s/C_r \quad (10)$$

where C_{cr} , is the Call Completion Rate, C_s is the incoming calls, C_r is the outgoing calls.

e. Call Quality Factor (C_{qf})

This index is gives the call quality ratio. It is given as shown in equation 11.

$$C_{qf} = N_{ra}/N_c \quad (11)$$

where C_{qf} is the Call Quality Factor, N_{ra} is the total number of abandonment rate, N_c is total number of calls.

f. Customer Expectancy (∂)

This quantity measures the strength of the tie between the network performances and agent efforts in serving the customers. The clearer the link, the more motivated a customer will be. This quantity depends on the agent utilization rate,

occupancy rate, and call abandonment rate. It is given as shown in equation 12.

$$\partial = (A_{ur} + O_r) + 1/C_{ar} \quad (12)$$

where ∂ is the Customer Expectancy, A_{ur} is agent utilization rate, O_r is occupancy rate, and C_{ar} is call abandonment rate.

g. Average Waiting Time (A_{wt})

This metric relates to instances where agents need to place customer calls on hold. While there are legitimate reasons for holding calls, contact centres should always minimize Average Waiting Time. It is given as shown in equation 13.

$$A_{wt} = \left(\frac{\text{Total Number of minutes Customers Spend Waiting}}{\text{Total Number of Calls}} \right) \quad (13)$$

h. Call Arrival Rate (C_R)

This is the total number of calls a contact centre receives within a specific time period. The time frame can be expressed by day, hour, or minute. This matrix is given as shown in equation 14.

$$C_r = N_c/T_t \quad (14)$$

where C_r is the Call Arrival Rate, N_c is the total number of calls, T_t is total time.

i. Service Level

This metric serves as a reliable indicator of overall call centre performance. Most companies set their ideal service level around cost efficiency. For example, a company might aim to answer at least 80% of all inbound calls within 20 seconds. It is then upon the call centre to meet this service level with the following attributes:

- a. Agent training
- b. Process improvement
- c. Technology upgrades

In fact, many companies turn to virtual call centre software to elevate their operational performance. There are three ways to calculate

Service Level, namely:

(Number of Calls Answered in Y seconds)/ (Total Calls Received) $\times 100\%$

(Number of Calls Answered in Y seconds)/ (Total Calls Answered + Abandoned Calls) $\times 100\%$

(Number of Calls Answered in Y seconds)/ (Total Calls Answered + Abandoned Calls Y seconds) $\times 100\%$

Service level can also be measured using the call quality factor of the network provider. It is given as shown in equation 15.

$$(1/C_{qf})/(L_s + 1/C_{sr}) \quad (15)$$

where L_s is the Service level, C_{qf} is the call quality factor, C_{sr} is the call setup service rate.

j. Call Volume

The service level L_s is related to the call volume V_c by a constant factor C_{qf} . It is given as shown in equation 16 and equation 17. Therefore,

$$L_s = V_c / C_{qf} \quad (16)$$

$$C_{qf} = V_c / L_s = N_{ra} / N_c \quad (17)$$

where L_s is the Service level, C_{qf} is the call quality factor, V_c is the call volume, N_{ra} is the total number of abandonment rate, N_c is total number of calls. The Adherence to schedule (A_{ts}), Total Unsuccessful Call Attempt (TUCA), Average Number Portability (ANP) and Service Level (L_s) is related to one another as shown in equation 18.

$$A_{ts} - TUCA - ANP = L_s \quad (18)$$

Multiplying the LS by a factor $1/CDR$ gives the Call Volume V_c . That is:

$$(1/CDR) L_s = V_c \quad (19)$$

Integrating Call volume V_c with respect to time gives the Occupancy Rate O_r . That is:

$$\int (dV_c)/dt = O_r \quad (20)$$

Multiplying the O_r by a factor $1/CSSR$ gives TUCA. That is:

$$O_r \cdot 1/CSSR = TUCA \quad (21)$$

Also, the relationship that exists between Handover success rate (Hsr), Attribution Rate A_{tr} , and Occupancy Rate O_r is given by:

$$Hsr(O_r) = A_{tr} \quad (22)$$

The relationship that exists between Attribution Rate A_{tr} , call abandonment rate C_{ar} and Delayed Number Probability (DNP) is given by:

$$A_{tr} - DNP = C_{ar} \quad (23)$$

Also multiplying C_{ar} by the inverse of Agent utilization rate A_{ur} gives the Arrival rate A_r . That is:

$$(C_{ar}) / A_{ur} = A_r \quad (24)$$

Integrating Arrival rate A_r with respect to time gives the Mobile Number portability (MNP). That is:

$$\int (dA_r)/dt = MNP \quad (25)$$

Multiplying MNP by Call Quality Factor (CQF) gives the Average Number Portability (ANP). That is:

$$(MNP) CQF = ANP \quad (26)$$

Also Multiplying MNP by the Average Waiting Time (Awt) gives the Delayed Number Probability (DNP). That is:

$$(MNP) Awt = DNP \quad (27)$$

Representing and implementing equations 18 to 27 in Simulink lead to successful MNP. Figure 1 shows the implementation of the service

operation on Simulink environment of MATLAB.

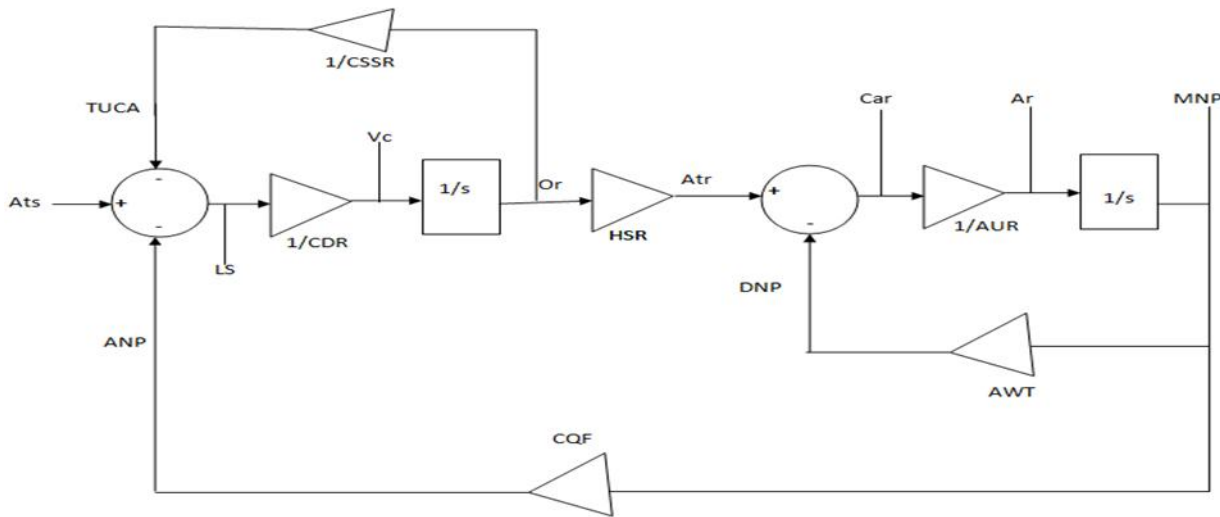


Figure 1: Simulink implementation of the portability model

3.2 Fuzzy Logic Technique

This section describes the fuzzy logic technique to determine the best network. The fuzzy rules and attributes used in fuzzy logic are convenient to modify. Users can easily modify the fuzzy member function as well as the fuzzy rules to obtain the most suitable output for the considered network environment. The basic steps of the fuzzy logic technique are:

- i. The burst inputs are taken from chosen attributes and degree to which inputs of info have a place with each appropriate fuzzy set is resolved. This process is called fuzzification.
- ii. At that point, this fuzzified input is taken and applied to the predecessor of the fuzzy principle.
- iii. Aggregation is the step in which all the inputs are considered and merged.
- iv. The output of the joined fuzzy set might be taken as input for defuzzification, and a single burst number is acquired as yield.

3.2.1 Fuzzification

In fuzzification, the input variables; Network Coverage, Tariff plan/Billing, Customer Services

are given a degree of suitable fuzzy sets. The burst inputs are a combination of Network Coverage, Tariff plan/Billing, Customer Services. The different possibilities for each attribute are given as below:

- i. Network coverage: (Poor, Average, Strong)
- ii. Tariff: (Cheap, Affordable, Expensive)
- iii. Customer service: (Unsatisfactory, Moderate, Satisfied)

To input and output variables, Figures 2–7 represent member function. For efficient computation, trapezoidal functions are used to design member function that gives excellent result. Figure 2 shows the input membership function of the tariff plan. Cheap, affordable and expensive are used in defining the tariff plan.

From Figure 2, it was seen that the degree of membership function for the tariff plan are equal, but the cost of the plan (kobo/sec) differs. When the cost of plan falls within 0 to 9.5 (kobo/sec), the tariff plan is said to be cheap. When it falls within 9.2 to 12.5 (kobo/sec), the tariff is said to be affordable. When it falls within 11.9 to 15(kobo/sec), the tariff is said to be expensive.

Figure 3 shows the input membership function of the network coverage. Poor, average and strong are used defining the network coverage. From Figure 3, it was seen that the degree of membership function for the network coverage are equal to 1, but the network coverage in decibel (dB) varies. When the network falls within -90 to -150 dB, the network coverage is said to be poor. When it falls within 0 to -110dB,

the network coverage is said to be average. When it falls within -20 to 50dB, network coverage is said to be strong.

Figure 4 shows the input membership function of the customer's services. Unsatisfaction, Medium and Satisfaction are used defining the customer's services.

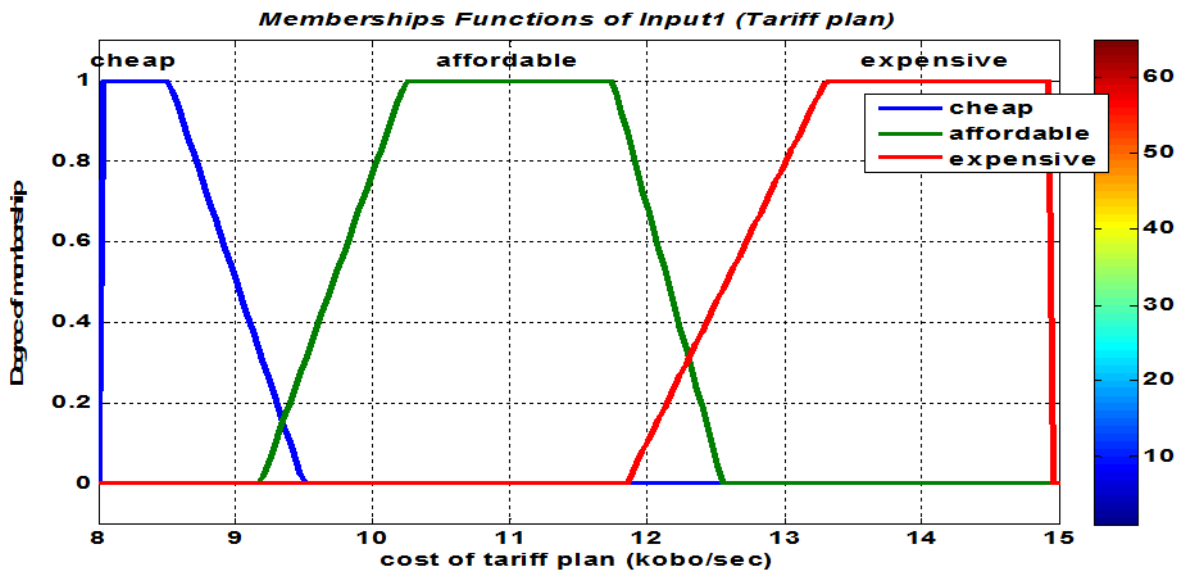


Figure 2: Input membership function1 (tariff plan)

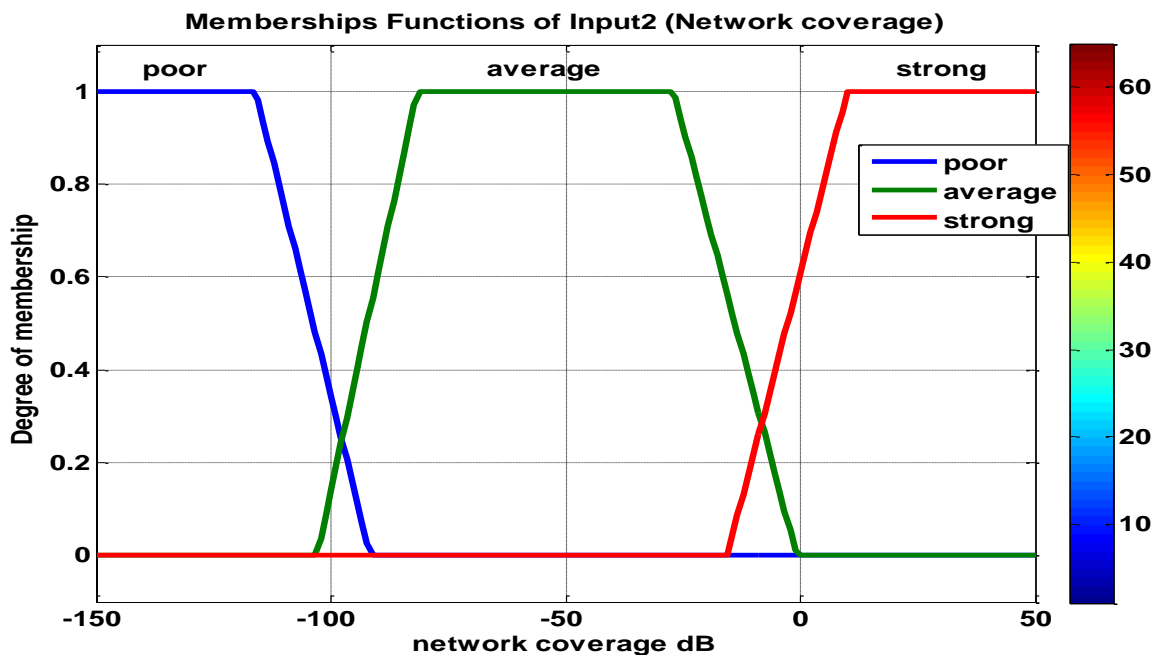


Figure 3: Input membership function 2 (network coverage)

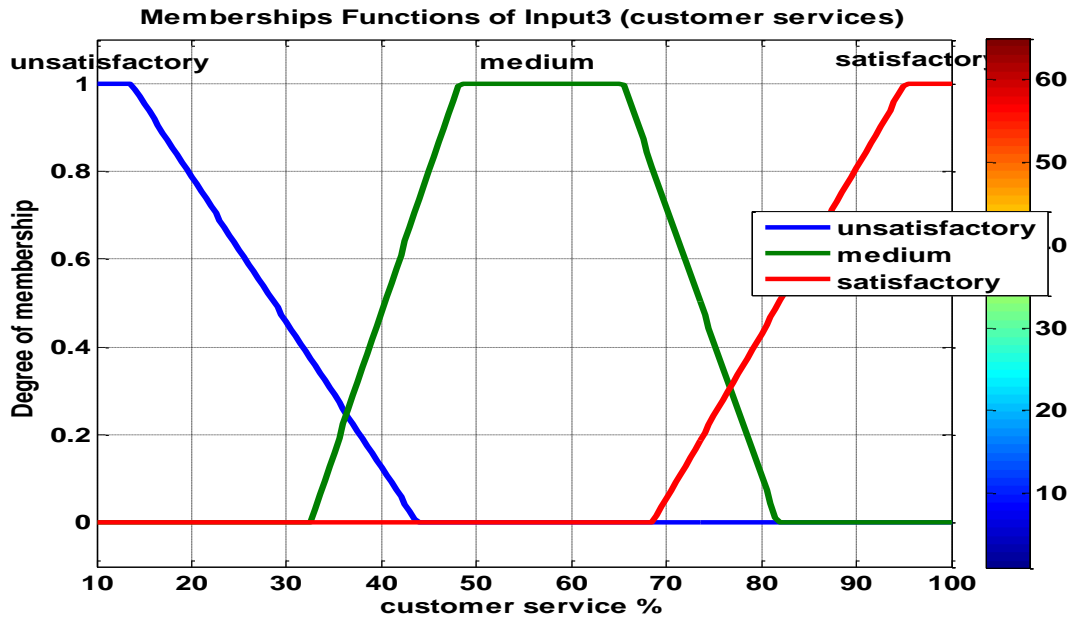


Figure 4: Input membership function 3 (customer service)

From Figure 4, it was seen that the degree of membership function for the customer service are equal to 1, but the service rendered varies in percentage. When the service ranged between 10 to 45%, the customer's service is said to be unsatisfactory. When it varies between 33 to 82%, the customer's service is said to be medium. When it varies between 69 to 100%, the customer's service is said to be satisfactory.

If all the conditions as seen in Figures 2 to 4 are satisfied, then it gives the best MNP. If any one condition is low, or medium, then the result gives a moderate MNP. If any one condition is satisfied, but the remaining is low or medium, then it gives the result as a bad network. Figure 5

shows SIMULINK model of the overall MNP model.

From the SIMULINK design of Figure 5, the output of the plots is considered in units to allow

the MATLAB Fuzzy inference system accumulate values. The values between -1 and 1 are used to rate degree of each membership functions considered. Note that the models seen in Figures 1 and 5 are Simulink models developed for the purpose of this research. Table 1 gives the average QoS KPI's data set for the various network operators in Nigeria from June 2022 to December, 2022. These KPI's data set was used in the simulation.

4.0 Results and Discussion

KPI'S are the metrics used by both network operators and customers to check the network operator performances. Variations in most call centre metrics are due to the changes in performances of the network operators. The KPI's considered in section 3 were used to measure the performance of the two dominant network operators in Nigeria, namely MTN NG and GLO NG in ABA (ABIA STATE),

UMUAHIA (ABIA STATE) and MBAISE (IMO STATE) by using the designed SIMULINK model in section 3. This metrics were also compared against the known NCC standards to be able to analyze the performance of the various

network operators in the considered region. The results also will go a long way to help a mobile user make MNP decisions. Figure 6 shows the Plot of customer expectancy/satisfaction for all network operators.

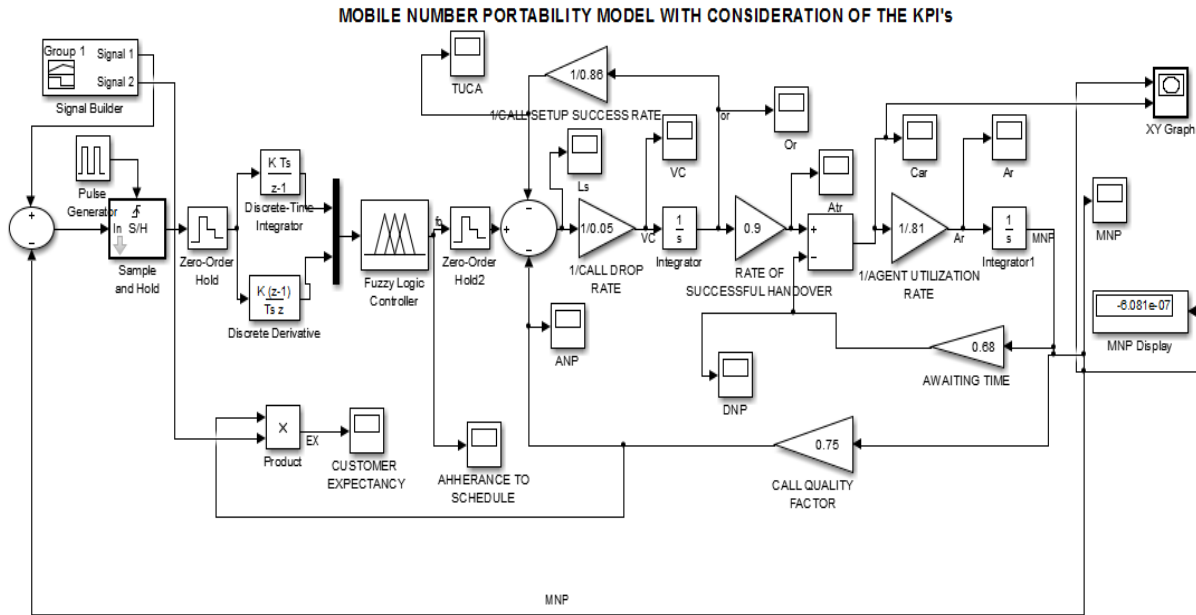


Figure 5: SIMULINK model of overall MNP model

Table 1: Average QoS KPI's data set for the various network operators in Nigeria from June to December, 2022

KPI	NCC	MTN NIG	GLO NIG
CSSR	0.9	0.89	0.86
HSR	0.9	0.8	0.9
CDR	0.02	0.04	0.05
AUR	1	0.9	0.81
AWT	0.5	0.65	0.68
CQF	0.98	0.90	0.75

As seen in Figure 6, the customer's expectancy is determined by the following KPI's: agent utilization rate, occupancy rate and arrival rate. The customer's satisfaction is the number of customers or percentage of total customers whose reported experience with firm, products, or its services exceeds specific satisfaction goals. The higher the value of these metrics, the better the customer's satisfaction. Since it is an expectation curve, the curve shows a fall from zero (area of

no expectation) before rising upwards showing areas of expectation. The spikes on each plot at 25 seconds indicate point of maximum satisfaction from each network operator. From Figure 6, at 25seconds which is the peak of the satisfaction curve, GLO NG produces the best expectation curve of 95.98%, followed by MTN and NCC with expectation curves of 95.00% and 94.71% respectively. Also the expectation curve

depends on the number of users operating on the identified network.

Table 2 shows a comparison table for the peak customer expectancy/satisfaction for the network operators considered in the month of June, 2020. From the overall average of expectancy/

satisfaction curve in the months of June 2022 to December, 2022 seen in table 2, it could be seen that GLO Nigeria has the best expectancy/satisfaction for their customers as compared to MTN Nigeria in the month under review. Figure 7 shows the plot call volume.

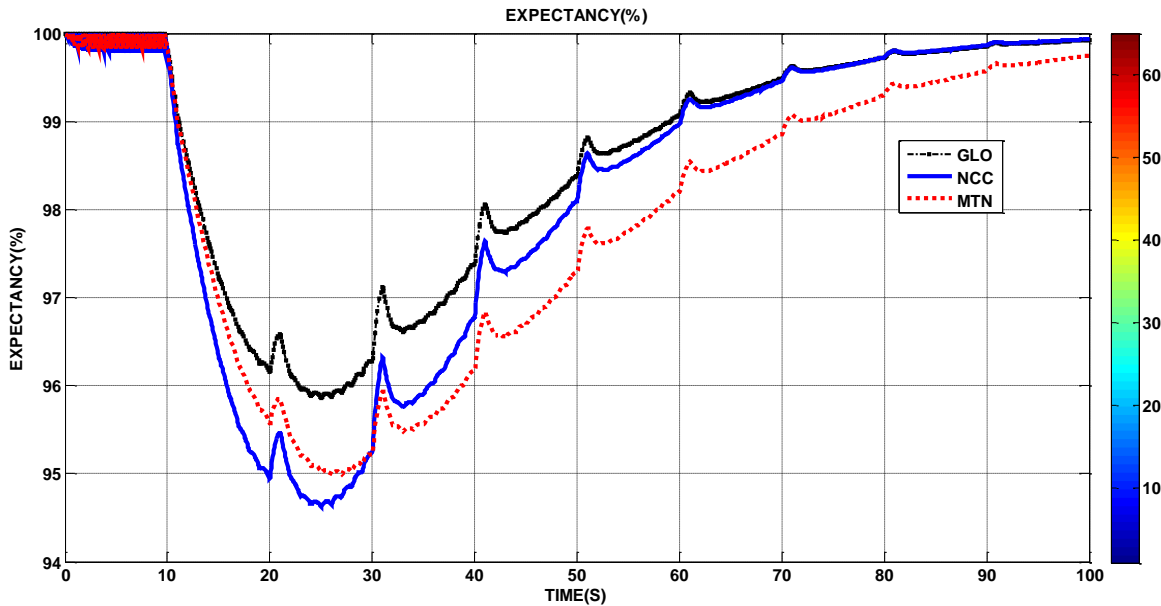


Figure 6: Plot showing customer expectancy/satisfaction for all network operators

Table 2: Comparison table for the peak customer expectancy/satisfaction curve for the network operators considered in June 2022 to December, 2022 as seen in Figure 6

NETWORKS	At 20sec	At 25sec	At 35sec	At 45sec	At 55sec	At 65sec	At 75sec
NCC	95%	94.71%	95.8%	97.3%	98.5%	99.2%	99.8%
MTN	95.50%	95.00%	95.5%	96.7%	97.7%	98.5%	99%
GLO	96.1%	95.98%	96.8%	97.8%	98.7%	99.3%	99.8%

Call volume is a metric used to measure the number of inbound calls in a given period. It is usually measured in a given time interval. The call volume impacts the agent’s workload, drives call centre staffing requirements and dictates call centre expenses. It equally determines the effectiveness of the agents working with the callers. From figure 7, it could be seen that the different networks have their call volumes. At 10secs, NCC call volume was 98.31%, MTN

99.21% and GLO was 99.30% respectively. While at 11secs; a rise to the call volume was experienced by the entire network. NCC took the lead with 102%, followed by MTN with 101.1% and GLO with 100.9%. The rise in call volume experience at 11sec could be as a result of busy hour or festive period. Table 3 shows a behavioural table for the call volumes for the network operators considered in the months of June 2022 to December, 2022 at the peaks as seen in Figure 7. From table 3, it could be seen

that at 10sec, more customers tend to connect to GLO than to MTN, while at 11sec; MTN has the higher customers trying to connect than the GLO

network in the month of June. Figure 8 shows the service level for all the networks considered in this research.

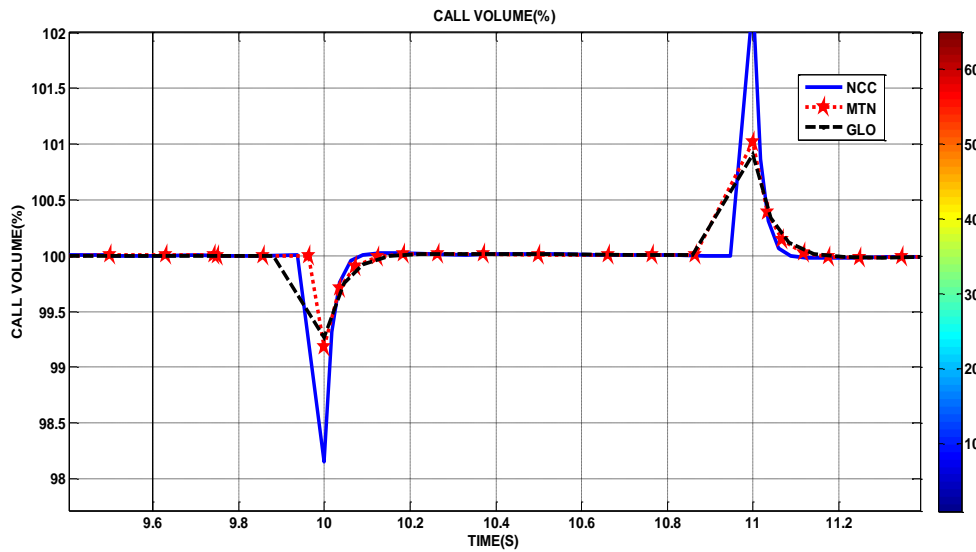


Figure 7: Plot of call volume

Table 3: A behavioural table for the call volumes for the network operators considered in the month of June, 2020 at the peaks

NETWORKS	At 10sec	At 11sec
NCC	98.31%	102%
MTN	99.21%	101.1%
GLO	99.30%	100.9%

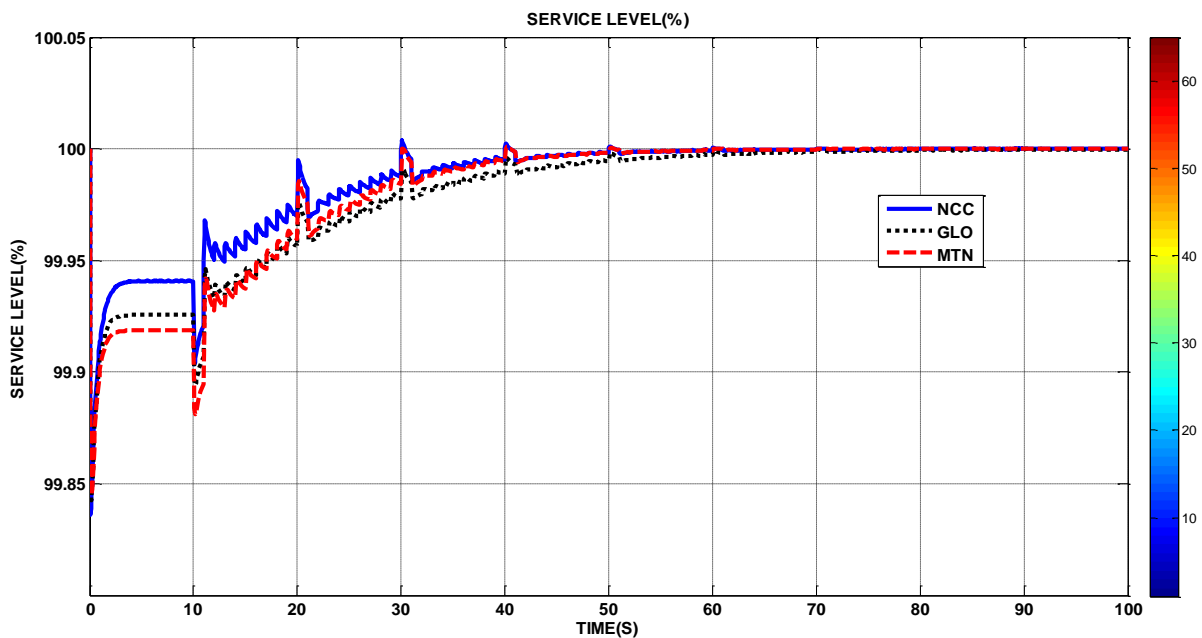


Figure 8: Plot showing Service Level for all networks

The higher the service level, the better the customer satisfaction. NCC service level was 99.91%, GLO NIG has service level of about 99.89% with MTN NG having service level 99.87%. The improved service level might be as a result of improved quality of services. These may include enhanced radio coverage, reduction of radio interface between subscribers, perfections in the functioning of the network, such as improved handover or cell-reselection attempts, efficient loading of the different elements of the network etc. Table 4 shows a comparison table for the peak service level for the network operators considered in the months of June 2022 to December, 2022 as seen in Figure 8.

From the plot of Figure 9, the spike represents the MNP rate for all networks. For instance MTN

NG and GLO NG shows spikes at the same time, but after a period of time, the rate of MNP for a user tending to port to GLO NG drops below the NCC target. The MNP in percentage at peak which occurs at 10sec for the different networks in the month of June are NCC 99.86%, MTN 99.87% and Glo 99.85%. MTN has the best MNP rate in the month of June at the peak. Table 5 shows a comparison table for the MNP change for the network operators considered in the months of June 2022 to December, 2022 as shown in Figure 9. From table 4, it could be seen that MTN has the best overall average service level (Retention level) as compared to GLO in the months of June 2022 to December, 2022. Figure 9 shows the plot of rate of MNP change. From table 5, it could be seen that MTN has a better MNP as compared to GLO in the in the Months of June 2022 to December, 2022

Table 4: A comparison table for the peak service level for the network operators considered in the months of June 2022 to December, 2022

NETWORKS	At 10sec	At 20sec	At 30sec	At 40sec
NCC	99.91%	99.99%	101%	101%
MTN	99.87%	99.97%	100%	100%
GLO	99.89%	99.96%	99.97%	99.98%

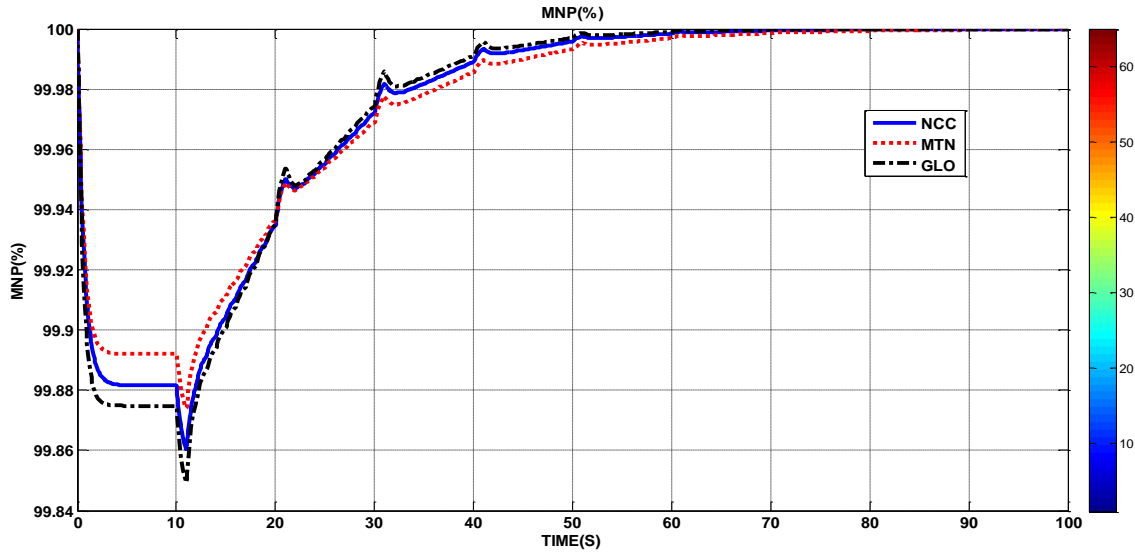


Figure 9: Plot showing rate of MNP change

Table 5: A comparison table for the MNP changes for the network operators considered in the months of June 2022 to December, 2022

NETWORKS	At 10sec
NCC	99.86%
MTN	99.87%
GLO	99.85%

5.0 Conclusion

In this research, a Fuzzy-Simulink model for MNP was developed. The two prominent network operators in Nigeria (MTN and GLO) were analyzed in the context of their KPI data which NCC regulates. The review findings lead to a novel method of subscriber migration in mobile cellular networks and its implementation framework in future mobile phones and devices. MNP decision using Fuzzy-Simulink framework was developed showing the customer parameters while focusing its evaluation based on a set of benchmarks which are considered as crucial for deployment while taking cognizance of user's requirements of mobile devices. From the results of the modeling of the KIPs, it was seen that the model was able to accommodate the various

parameters needed for subscribers to port from a particular network to the other.

In the months of June 2022 to December, 2022, GLO NG produces the best expectation curve of 96.1% at the peak. It could also be seen that the different networks have their call volume. NCC took the lead with 102%, followed by MTN with 101.1% and GLO with 100.9%. NCC service level was the best at the peak of 99.91%. The improved service level might be as a result of improved quality of services. These may include enhanced radio coverage, reduction of radio interface between subscribers, perfections in the functioning of the network, such as improved handover or cell-reselection attempts, efficient loading of the different elements of the network etc. MTN has the best MNP rate in the months under consideration.

This research recommends that NCC should as a matter of fact persuade the implementation of MNP design to circumvent network user's exploitation while convincing network providers to initiate an enhanced system that will progress QoS.

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