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A Model To Estimate The Earning of Mobile Communication Network Using Sensitivity Analysis

Mohammed Tahseen Al Agha[1], Amin Babiker A. Mustafa[2]
[1]*Department of Electronics Engineering, Jordanian Sudanese College For Science & Technology*
[2]*Dept. of Computer Engineering, Faculty of Engineering, Al Neelain University, Khartoum, Sudan*

Abstract: - This paper provides a simulation-based approach of assessing the risk and uncertainty involved in estimating the expected earnings of a mobile communication company according to traffic intensity principle. The procedure involves using of sensitivity analysis modeling, and spreadsheet software, such as Excel, is a common tool for performing this model. Sensitivity analysis is an analysis that finds out how sensitive an output is to any change in an input while keeping other inputs constant. This leads stakeholders and team risk management to avoid the risks associated to cost by taking attention to the five parameters related to mobile traffic intensity such as number of users, number of calls, call duration, initial cost of call duration, and price of call duration.
Keywords: - *Decision making, modeling, trunking theory, risk assessment, sensitivity analysis.*

I. INTRODUCTION

Accurate traffic dimensioning plays an important role in telecommunications network planning and is particularly important for the performance analysis of mobile and wireless networks. Traffic analysis and optimization is thus paramount importance for network planning and design.

Cellular systems use the concept of trunking to accommodate a large number of users in a limited radio spectrum. In fact, only a few hundreds of lines are needed owing to the relatively short duration of a call. This indicates that the resources are shared so that the number of lines is much smaller than the number of possible connections. A line that connects switching offices and that is shared among users on an as-needed basis is called a trunk. To design trunked radio systems that can handle a specific capacity at a specific “grade of service", it is essential to understand trunking theory. The fundamentals of trunking theory are developed by Erlang. Today, the measure of traffic intensity bears his name. Trunking mainly exploits the statistical behavior of users so that a fixed number of channels can be used to accommodate a large, random user community. As the number of telephone lines decrease, it becomes more likely that all channels are busy for a particular user.

User calling can be modeled statistically by two parameters: the average number of call requests per unit time λ_{user} and the average holding time H. The parameter λ_{user} is also called the average arrival rate, referring to the rate at which calls from a single user arrive. The average holding time is the average duration of a call. The product of the average arrival rate and the average holding time is called the offered traffic intensity or offered load as shown in eq. 1.

$$A_{user} = \lambda_{user} H \qquad (1)$$

A sensitivity analysis is a powerful technique for understanding systems especially in trunking system. Sensitivity Analysis of the effectiveness criterion for investment project evaluation is the calculating procedure of researching and determining the effect of changes of individual values taken into the calculation on the values of individual criteria, as well as on the final investment project evaluation. In other words, it is a procedure that analyses how the changes of certain input values (income, costs, value of investments, etc.), produced due to inappropriate prediction or for some other reason, influence certain criteria values and the total investment project evaluation. Applying this analysis it is possible to find the maximum or minimum points which one value may take while, however, still allowing an investment project to be justified and acceptable for realization.

II. METHODOLOGY

The applied methodology is based on sensitivity analysis which is a type of quantitative risk analysis. Sensitivity analysis is a variation on scenario analysis that is useful in pinpointing the areas where forecasting risk is especially severe. The basic idea with a sensitivity analysis is to freeze all of the variables except one and then see how sensitive our estimate is to changes in that one variable. This section represents how the telecom’s

profits can be turned around depending on the change of different input variables such as number of users, number of calls, call duration, price of call duration per second, and the cost of call duration per second.
It should be remembered that the traffic intensity per one user for a telecom network is equal to number of calls times the calls duration according to eq. (1). So that, the total traffic intensity is equal to traffic intensity per one user times the number of users denoted by U. The telecom's profits can be described in the next equation:

$$\text{Profits} = U * \lambda * H * (\text{price of making a call \textbackslash sec} - \text{initial cost for a call\textbackslash sec}) \qquad (2)$$

III. MODELING AND RESULTS

Based on eq. 2, telecom traffic intensity at different cases can be constructed in table 1.

Table 1 : Telecom Traffic Intensity Different Cases

Different Levels	Low	Medium	High
No. of users	9,000	10,000	11,000
No. of calls per day	1	3	5
Call duration per sec.	60	120	180
Price in $	0.048	0.05	0.052
Initial Cost in $	0.037	0.04	0.043
Profit $ per day	5,940	36,000	89,100

In table 1 assumed values for profits are applied as low (pessimistic case), medium, and high (optimistic case). The medium case is the most likely to occur and is considered as the base of profit calculations. For example, in medium case, the number of users are assumed to be 10,000, number of call per day are 3 calls, call duration per second for one user is 120 second, price of making a call is 0.05 USD for one second, and the initial cost of instillation is 0.04 USD for one second. So, telecom profits are equal to 36,000 USD per day. According to table 1 and eq. 2, the telecom profits at different factors are calculated as illustrate in next table:

Table 2 : Telecom's Profits for Different Values

No.	Profit (K $)	No. of users	Average No. of call\user	Average call duration\user in sec	price\sec in $	Initial cost\sec in $
1	36	10,000	3	120	0.05	0.04
2	32	9,000	3	120	0.05	0.04
3	40	11,000	3	120	0.05	0.04
4	12	10,000	1	120	0.05	0.04
5	60	10,000	5	120	0.05	0.04
6	54	10,000	3	180	0.05	0.04
7	18	10,000	3	60	0.05	0.04
8	29	10,000	3	120	0.048	0.04
9	43	10,000	3	120	0.052	0.04
10	47	10,000	3	120	0.05	0.037
11	25	10,000	3	120	0.05	0.043

It's obvious that profits are altered for any parameter value change. For instance, in the most likely case the profit is 360,000 $. In row 4 of table 2, if the average number of calls\user decrease from 3 calls per day to one call per day, the telecom profits will reduced to 120,000 $, whereas if the average number of calls\user increase from 3 calls per day to 5 calls per day (as shown in row 5), the telecom profits will increase to 600,000 $. The same concept for other parameters can be applied.
In order to build up a tornado diagram which is a model of sensitivity analysis, telecom profits table should be constructed with probable different profit values as demonstrated in table 3.

Table 3 : Telecom Profits at Different Variables

Profits in K $	Low	Most likely	High
Tolerance of (No. of users)	32	36	40
Tolerance of (No. of call)	12	36	60
Tolerance of call duration	18	36	54
Tolerance of price	29	36	43
Tolerance of cost	25	36	47

Now, using excel spread sheet and data of table 3, a tornado diagram can be plotted as depicted in graph 1.

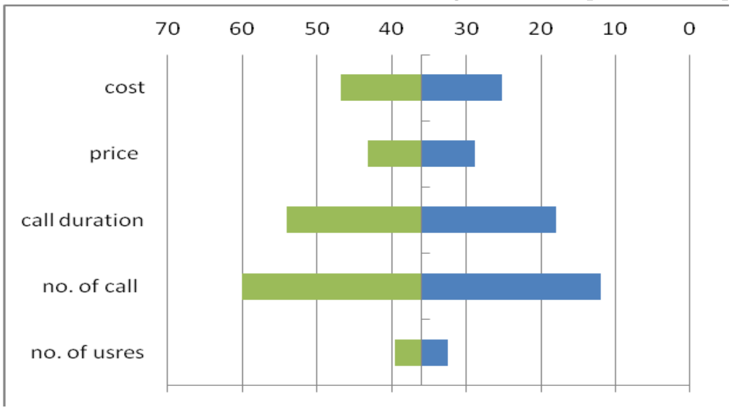

Figure 1 : Tornado Graph

Graph 1 can be arranged in order to meet classical tornado diagram as follows:

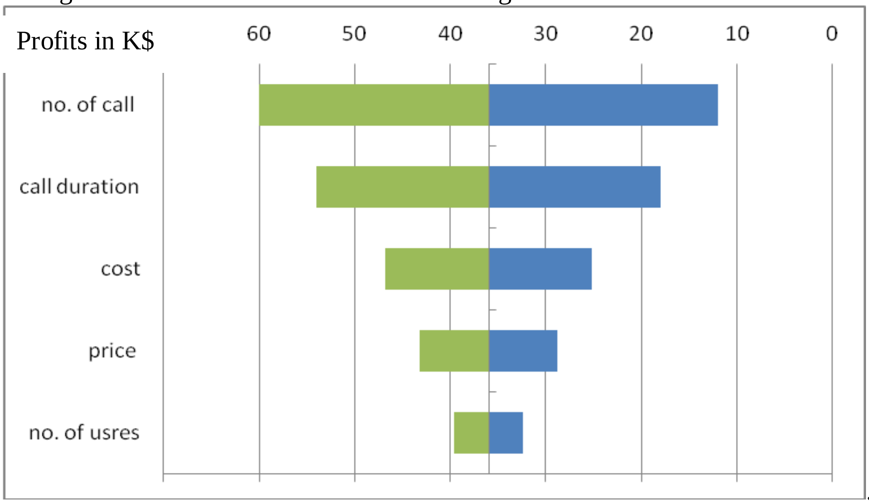

Figure 2 : Final Tornado Graph

It's clear from fig. 2, the greater the distance of bar, the greater the sensitivity to fall in risk in the right side. and vise versa is correct. So, risk managers can directly determine when risk could occur using tornado analysis model. The left side indicates increasing the telecom profits, while as right side means decreasing the profits below the most likely estimation. The uncertainties in the unit price, the unit sales, and the other variable costs, affect the expected earnings positively or negatively. Another important issue observed is that the factors of "No. of calls" and "call duration" are the parameters which should taken into consideration to increase telecom profits. Competitive offers for calls should be approved to encourage subscribers to make calls. The coefficient of "No. of users" is less reliable, since a lot of subscribers have a SIM card, but not using it Periodically. Also, interested in reducing initial cost help to increase profits instead of increasing the price of making calls.

The previous calculations for profits leads stakeholders and risk managers to avoid risks in the cost by taking attention to these five factors to ensure that the decline is not less than the base values.

IV. CONCLUSION

It has been shown from the results that sensitivity analysis can determine how different values of an independent variable of telecom traffic intensity will impact the profits under a given set of assumptions. Sensitivity analysis indicates to the decision-maker to determine the variables that affect the cash flow expectations. This is assisted to understand the investment venture in its entirety.

The concept of risk should be extend to include net present value (NPV) concept which is another significant issue to be discussed. It is an important investment project evaluation index and received extensive attention. NPV and risk have a strong relation with each other.

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