



INSTITUTO FEDERAL DE
TELECOMUNICACIONES

A Statistical Framework to Monitor the Quality of Service in Mobile Networks

Regulatory Policy Unit
Federal Institute of Telecommunications,
Mexico

BACKGROUND

- Foster competition in telecommunication services through regulation → minimum standards for Quality of Service
- There are not yet normalized technical specifications or recommendations targeted for regulators that cover KPI or statistical methodologies to obtain national level results
- Resolution 95 (Hammamet) from the ITU:
 - References to create national measurement frameworks, strategies & testing methodologies to monitor QoS
 - Provide guidance to regulators
- Representative samples are needed to produce QoS monitoring results at a national level

NEW REGULATION – GUIDELINES FOR MOBILE SERVICE

- The IFT has approved the guidelines to establish the new quality of service standard for the mobile service
- Competition through the publication of QoS measurement's results
- Empowered users make informed decisions
- Mexico has one of the highest monetary sanctions for QoS → Statistical robustness to justify penalties imposed to operators
- To complement QoS monitoring with QoE measurements (mobile apps, indoor measurements, highways, etc)
- Minimum requirements for the support & complaints management systems
- Methodology to monitor QoS defined KPI
- Publication of coverage maps that are accessible, comparable and user-friendly

NEW SYSTEM OF METRICS – VOICE & SMS

SANCTIONABLE

UNSUCCESSFUL CALL
RATE

$\leq 3\%$

DROP CALL RATE

$\leq 2\%$

UNSUCCESSFUL SMS
RATE

$\leq 2\%$

INFORMATIVE

MEAN CALL SETUP
TIME

VOICE QUALITY
(MOS)

MEAN SMS DELIVERY
TIME

SMS INTEGRITY

NEW SYSTEM OF METRICS – DATA SERVICE

ACCESIBILITY

DOWNLINK/UPLINK
AVERAGE SPEED

LATENCY

PACKET LOSS RATE



To be published per
access technology

STATISTICAL MODELING APPROACH

➤ Two-steps model:

➤ First step:

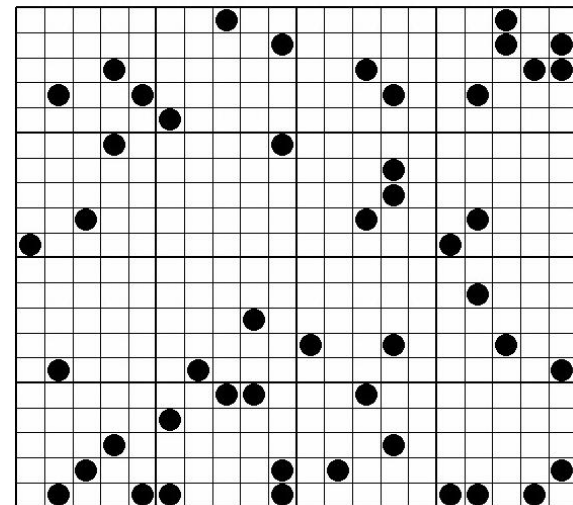
❖ Stratified Random Sampling

❖ Select the geographical locations to be measured in the country

➤ Second step:

❖ Simple Random Sampling

❖ Determine sample size for each of the geographical regions



STRATIFICATION

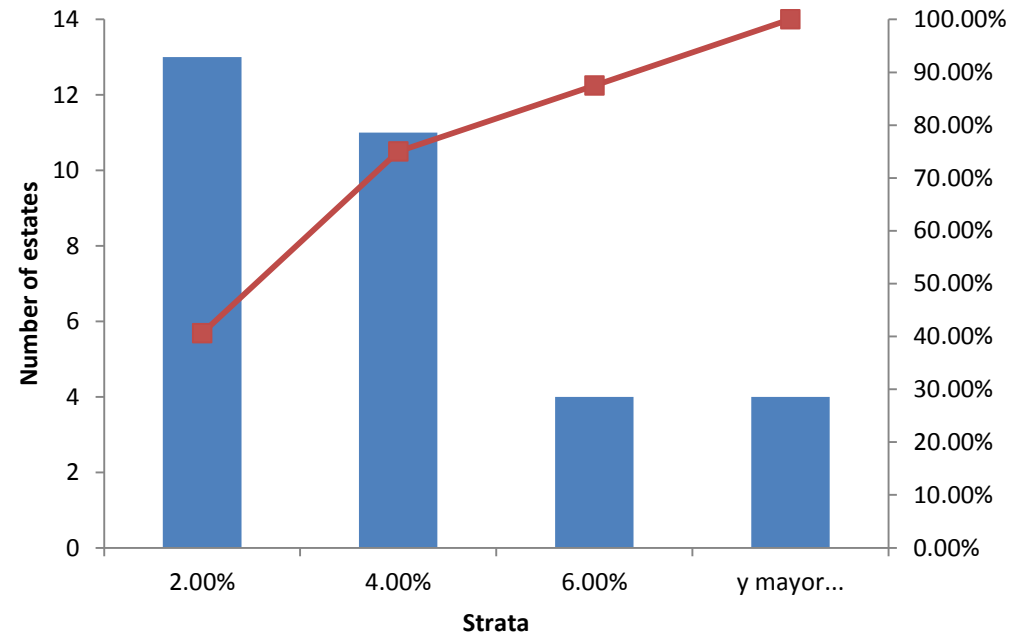
- Construct the strata by selecting non-overlapping groups from the geographical regions in the country
- Stratification is used to produce a smaller bound on the error of estimation than would be produced by a simple random sample of the same size alone
- Determine the number of estates to be measured every year:

$$n = \frac{(\sum_{i=1}^L N_i \sigma_i)^2}{N^2 D + \sum_{i=1}^L N_i \sigma_i^2}$$

$$n_i = n \left(\frac{N_i \sigma_i}{\sum_{i=1}^L N_i \sigma_i} \right)$$

$$i = 1, 2, 3$$

% population covered by estate



Where:

L = Total number of strata (L = 3);

σ_i = expected standard deviation for stratum i ;

N_i = number of estates in each stratum

N = total number of estates

$D = \frac{B^2}{4}$, where B is the bound on the error of estimation;

n_i = total number of estates in stratum i , and

n = number of estates to be measured

SIMPLE RANDOM SAMPLING

- Used to define the number of events needed to measure certain KPI with a defined confidence level and error of estimation

- Sample size:

$$m_i = \frac{z_{1-\alpha/2}^2}{a^2} \cdot \left(\frac{\sigma_i}{\bar{x}_i} \right)^2$$

$$\bar{x}_i = \frac{\sum_{k=1}^{m_i} x_k}{m_i}$$

Where:

m_i = simple size for stratum i ;

$z_{1-\alpha/2}$ = percentil $1 - \alpha/2$ of a standard normal distribution;

$1 - \alpha$ = confidence level;

a = bound on the error of estimation;

\bar{x}_i = mean value for the parameter under observation in stratum i , and

σ_i y \bar{x}_i are calculated from previous measuring campaigns.

OBTAINING NATIONAL LEVEL RESULTS

- A weight is defined based on the population on each stratum N_i with respect to the total population N

$$w_i = N_i / N$$

- Weighted values for mean and standard deviation for the KPI based on the mean values for each stratum i :

$$\bar{x} = \sum_{i=1}^L w_i \bar{x}_i$$

$$\sigma^2 = \sum_{i=1}^L w_i^2 \sigma_{\bar{x}_i}^2$$

$$\sigma_{\bar{x}_i}^2 = \frac{\sigma_i^2}{m_i}$$

- Hypothesis testing to determine if the operator achieves the thresholds established by the regulator (statistical inference):

$$x_{st} = \frac{\bar{x} - \mu}{\sigma}$$

$Z_{1-\alpha} = 1.64$ for a standard normal distribution with a significance level of 5%

If the test statistic (x_{st}) is greater than or equal to a critical value $z_{1-\alpha}$, then, statistically, there is not sufficient information to reject the null hypothesis with a significance level of α ; *otherwise*, the null hypothesis is rejected and the alternative hypothesis is accepted;

RECOMMENDATIONS

- To achieve national level metrics, different variables have to be taken into account:
 - ❖ Geographic extension to cover
 - ❖ Characteristics of geographical regions
 - ❖ Cost
 - ❖ Resources (time, equipment, human resources)
- Representative samples can be achieved through stratification and simple random sampling
- It is important to “calibrate” the formulas with results obtained from each measurement’s campaign
- A methodology should define the duration of each event (for example, duration of the test, guard time intervals, setup time, time between events)
- With the KPI definition and the testing methodology, it is possible to obtain the number of working days needed to perform a measurement campaign

QUESTIONS

Tania Villa Trápala
IFT, México
tania.villa@ift.org.mx