

Enhancing the Quality of Mobile Network Operator Data with a traditional survey with the right questions

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Abstract

Mobile network operator (MNO) data has increasingly become popular to produce statistics that are in a wide sense based on the position or mobility of individuals. However, multiple sources of bias such as multiple device usage, mismatches between the device and user, and diverse usage patterns across different demographic groups compromise the quality of insights drawn from these data sources. This paper tries to advocate for the implementation of a specialized survey (or a questionnaire module within an existing survey) within the European Statistical system aimed at addressing these biases. By detailing the motivations for different target variables, methodologies and expected outcomes of the survey, we want to show the potential to significantly improve the quality and reliability of MNO-derived statistics.

Keywords: mobile network operator data, MNO, questionnaire

1. Introduction

Mobile network operators (MNOs) generate, and store vast amounts of data generated from telecommunications interactions. These data could be invaluable for policy making, market analysis, and understanding public behaviours in general. However, the reliability of conclusions drawn from MNO data is often undermined by various biases. These issues need to be addressed before official statistics products can be produced based on MNO data. To address these issues, this paper proposes a survey aimed at identifying and correcting these biases. This would improve the usability of this data source in statistical and analytical applications.

2. Background and motivation

2.1 Current challenges with MNO data

MNO data usage, while providing high frequency data that cover most of the population, has several challenges:

- **Device-User Mismatch:** Often, the individual paying for a service (the contract holder) is not even primary user of the device or SIM card. Family plans and business contracts further blur the lines between the contract holder and the actual users. However, often socio-demographic information is used in current analytical project with MNO data.
- **Multiple Devices and/or SIM cards:** Individuals may use multiple devices or SIM cards, leading to duplication in records or skewed usage statistics, so to over-coverage of certain groups within MNO data.
- **Different User Behaviour:** Usage patterns can vary dramatically between users. These heterogeneities could be based on factors like age, employment status, and lifestyle, therefore affecting the generalizability of derived statistics. The usage behaviours include that some groups might switch off their (or one of their) phone(s) during the night, during work or during vacation (in case of business phones).

2.2 The need for a dedicated survey

To decrease the influence of these issues on the statistical output, a targeted survey can systematically collect data on the number of devices per individual, the actual usage patterns, and the socio-demographic profiles of users. This approach is aimed at both quantifying the biases and providing corrective measures to enhance data accuracy.

3. Survey design and implementation

3.1 Survey objectives

The primary objectives of the survey are:

- To determine the actual number of devices and SIM cards used by individuals and explained by socio-demographic background variables.
- To identify and quantify the discrepancies between contract holders and device users.
- To analyse device usage patterns across different demographic groups.
- To collect comprehensive socio-demographic data of both contract holders and actual device users. The sampling units are individuals that correspond to the actual device

users. Information on socio-demographic background might not be surveyed but used directly from an information-rich sampling frame.

3.2 Questionnaire design

The questionnaire is meant as a core module for this topic with the possibility to be extended for specific statistical domains. It includes sections on:

- Device and SIM Card Usage: Questions on the number of devices, their purposes, and details on SIM card usage.
- Contractual Relationships: Information on the contract owner, duration with current service provider, and previous providers.
- User Demographics and Lifestyle: Questions on age, gender, household composition, employment status, commuting habits, and usage during different activities and travels.

3.3 Sample design

The questionnaire is designed to survey individuals about a specific, mostly legal, age limit, e.g. in the case of Austria, 16-year-olds. A random sample of individuals living in the country should be drawn and stratification can be used to increase the representativeness across different demographics and regions. Oversampling of certain groups can also be used to compensate for differences in response behaviour.

4. Expected outcomes and implications

4.1 Analysis methodology

As mentioned, the primary objective of the survey is to adjust MNO data with respect to duplication and representativity, for the resident target population. Hence, the survey is not target specific and will provide results useful in different domains. However, some specific statistical outputs might require specific adjustment, including the inclusion of dedicated questions in the questionnaire, or a different survey design. E.g. inbound tourism statistics will require the definition of a different target population compared to the country residents, and consequently different survey design and techniques, as outlined in section 5.

4.2 Enhancements in Data Quality

The survey is expected to significantly improve the representativity of MNO data. Accurate assessments of the user behaviours and demographic profiles will allow overcoming to rely on mobile market shares for the expansion of MNO data, whilst provide results based on official statistics practices, advantages even for the mobile operators.

4.3 Policy and Decision Making

Improved data quality will bolster the reliability of policy decisions made based on mobile data analytics.

5. Alternative Scenarios

An alternative sample design is to sample areas (antennae) and consider in the sample all individuals connected to the selected antennae in a given time interval. This design would have the benefit of considering the actual present population in the country. However, it presents technical and possibly legal issues for implementation.

An alternative approach compared to the design and carrying out of a devoted survey, can be based on a quasi-randomization approach, aiming to assess a general selection model for MNO data to gain representativity for MNO-based measurements. The quasi-randomization could overcome common issues of sample survey, their cost, the response burden and the non-response, the limitation to topics explicitly investigated in the questionnaire.

6. Conclusion

The proposed survey and its questionnaire represent a critical step towards quantifying and reducing the prevalent biases in MNO data. By aligning actual user behaviours with statistical models, the European Statistical system can lead the way in transforming mobile data into a more reliable source for insights and therefore for policy making.

This paper outlines not only the necessity but also the methodology and potential impacts of such a survey. We this background, we are advocating for its implementation across the ESS countries.

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A. Annex - Questionnaire: Use of mobile data

I. Mobile devices and contracts

1. How many mobile phones do you use? Please include all mobile phones used for private and business purposes.

2. How many SIM cards (incl. eSIM) do you use in your (alias: .../first/second/third) mobile phone?

3. For which purposes is your (alias: mobile phone/first/second/third SIM card) used?

- a. Private purposes
- b. Business purposes
- c. Both

4. A) Which service provider do you use for your mobile phone?

B) Which service provider do you use for your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone?

Provide a dropdown menu with all service providers. The menu should include the options "Other service provider located in my country of residence" and "Other service provider located abroad"; if "Other service provider located abroad" -> 5, else -> 6

5. A) In which country is the service provider of your mobile phone located?

B) In which country is the service provider of your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone located?

Provide a dropdown menu with all countries.

6. A) Have you been with your service provider for more than a year?

B) Have you been with the service provider of your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone for more than a year?

- a. Yes -> 7
- b. No -> 9

7. A) Which service provider did you have before your current one?

B) Which service provider did you have before your current one for your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone?

Provide a dropdown menu with all service providers. The menu should include the options "Other service provider located in my country of residence" and "Other service provider located abroad"; if "Other service provider located abroad" -> 8, else -> 9

8. A) In which country is the service provider you had before your current one located?

B) In which country is the service provider you had before your current one for your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone located?

Provide a dropdown menu with all countries.

9. A) Who is the contract owner of your mobile phone?

B) Who is the contract owner of your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone?

- a. Myself -> 13
- b. Other person -> 10
- c. My business (for self-employed) -> 13
- d. My employer -> 13

10. What is the relationship to the contract holder?
- My parent
 - My partner (e.g. wife/husband, girlfriend/boyfriend)
 - My child
 - Other person not listed here: _____

11. How old is the contract holder?

Don't know

12. Which gender does the contract holder identify with?
- Female
 - Male
 - Non-binary
 - A gender not listed here
 - Prefer not to say
 - Don't know

13. Do children under 16 live in your household?

- Yes -> 14
- No -> 17

14. How many children under 16 live in your household?

15. How many of them have their own mobile phone with an active SIM card?

_____ 0 -> 17, >0 -> 16

16. Please provide for every child under 16 who has access to their own mobile phone with an active SIM card, how old they are.

II. Use of mobile devices in everyday life

17. What best describes your livelihood situation?

- Employed -> 18
- Self-Employed -> 18
- In school or university -> 18
- Unemployed -> 20
- Out of labor force (e.g. homemaker) / Retired-> 20

18. Do you commute to (alias: work/school or university) on at least one day per week?

- Yes, within the country -> 20
- Yes, crossing borders to another country -> 19
- No -> 21

19. To which country are you commuting?

Provide a dropdown menu with all countries. Put the neighboring countries first.

20. On average, how many days a week do you commute?

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21. Is your mobile phone with you all the time?
a. Yes
b. No
22. Is your mobile phone switched on all the time?
a. Yes -> if 21a, then 24, if 21b, then 23
b. No -> 23
23. When is your mobile phone not with you or switched off?
a. During work, school or university
b. During sleep
c. Other activity not listed here: _____

III. Use of mobile devices during travels

24. Did you travel abroad in the last 12 months?
a. Yes -> 25
b. No -> 35
25. Where did you travel abroad in the last 12 months?
a. Inside the EU
b. Outside the EU
c. Both
26. What was the purpose of your travels abroad?
a. Business purposes -> 31
b. Private purposes -> 27
c. Both -> 27
27. A) In your travels abroad for private purposes to an EU country, do you use your mobile phone?
B) In your travels abroad for private purposes to an EU country, do you use your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone?
a. Yes -> Routing
b. No -> Routing
28. A) Do you leave your mobile phone on most of the time each day during your travels for private purposes within the EU?
B) Do you leave your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone on most of the time each day during your travels for private purposes within the EU?
a. Yes -> Routing
b. No, it is switched off or in flight mode most of the times -> Routing
29. A) In your travels abroad for private purposes to a Non-EU country, do you use your mobile phone?
B) In your travels abroad for private purposes to a Non-EU country, do you use your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone?
a. Yes -> Routing

b. No -> Routing

30. A) Do you leave the mobile phone on most of the time each day during your travels for private purposes outside the EU?

B) Do you leave your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone on most of the time each day during your travels for private purposes outside the EU?

a. Yes -> Routing

b. No, it is switched off or in-flight mode most of the times -> Routing

31. A) In your travels abroad for business purposes to an EU country, do you use your mobile phone?

B) In your travels abroad for business purposes to an EU country, do you use your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone?

a. Yes -> Routing

b. No -> Routing

32. A) Do you leave the mobile phone on most of the time each day during your travels for business purposes within the EU?

B) Do you leave your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone on most of the time each day during your travels for business purposes within the EU?

a. Yes -> Routing

b. No, it is switched off or in-flight mode most of the times -> Routing

33. A) In your travels abroad for business purposes to a Non-EU country, do you use your mobile phone?

B) In your travels abroad for business purposes to a Non-EU country, do you use your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone?

a. Yes -> 36

b. No -> 37

34. A) Do you leave the mobile phone on most of the time each day during your travels for business purposes outside the EU?

B) Do you leave your (alias: first/second/third) SIM card in your (alias: first/second/third) mobile phone switched on most of the time each day during your travels for business purposes outside the EU?

a. Yes

b. No, it is switched off or in-flight mode most of the times