

The Built Environment and Syrian Refugee Integration in Turkey: An Analysis of Mobile Phone Data

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ABSTRACT

We use a large call detail record (CDR) dataset from mobile operator Türk Telekom to examine how refugees from the Syrian Refugee Crisis are integrating into Turkish society. We extract different types of callers from the social network: refugees who often call Turkish nationals, refugees who do not call Turks; Turks who often call refugees, and Turks who do not call refugees. We consider frequent phone calls between refugees and Turks to indicate high levels of bridging social capital for these users and that refugees tied to Turkish nationals through calls have integrated into the Turkish society, economically and/or socially. We also assume that Turks who often call refugees are investing in creating these relationships (although these comprise a relatively small set of users).

Each user is geolocated based on the cell towers they use, to produce an activity space that approximates the parts of the country/city frequented over a time span. We ask: in what kinds of landscapes do these "bridging" members of Turkish society live? We overlay their activity spaces with infrastructural and socioeconomic indicators (i.e. distance from the Syrian border, intersection with urban amenities, etc.), and statistically measure the extent to which these users differ from the average user in the network.

We found few significant geographic patterns for refugees who were calling Turks often. However, bridging Turks were found to be located near infrastructural variables such as places of worship, schools, community centers, and social centers/facilities, more often than their non-bridging counterparts. These differences were strongest in locales with Muslim and Sunni Muslim places of worship. In these locales, presumably, refugees and Turkish nationals share common values and beliefs. Our results provide quantitative evidence suggesting the significance of social amenities and meeting places for face-to-face connection and social support for the livelihoods of refugees and refugee integration.

CCS CONCEPTS

• Human-centered computing → Mobile phones; • Applied Computing → Law, social and behavioral sciences.

KEYWORDS

refugee integration, social relationships, points of interest, CDRs, mobile phones, GIS, humanitarian

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1 INTRODUCTION

Since the beginning of the Syrian Civil War in 2011, over 5.6 million Syrians have fled from their homeland to neighboring countries Jordan, Lebanon, and Turkey. Turkey hosts the largest number of Syrian refugees, increasing by around 1,000 per day. As a result of this humanitarian crisis, Syrians have tended to resettle on the border and in cities. For example, about 560,000 registered Syrian refugees reside within the city of Istanbul [20].

As Syrians arrive in Turkey, the Turkish government is confronting the challenge of helping refugees to successfully integrate into their new community amid tension between refugee immigrants and Turkish nationals. Globally, refugees frequently face anti-immigrant attitudes. In Turkey, "Anti-Syrian" sympathizers fear joblessness, a slowing economy and increased crime as a result of relaxed immigration policies, deterioration of public facilities, and price increases resulting from refugee immigration [20]. Syrian refugees have reported reluctance to reveal their nationality in fear of retaliation. In one interview, a refugee related: "When they hear that I'm Syrian, they will treat me bad. They show their anger, I don't know why" [18]. One survey of over 100 countries found that 42.1% of Turks knew an immigrant (not necessarily a refugee immigrant), which comprise about 5.8% of the country [14]. The survey also reported that the average Turk tended to be less accepting of migrants than residents of other nations [14], although this finding should not devalue the contribution of the Turkish individuals who are trying to help refugees integrate into Turkey.

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Despite clashes between the groups, refugee integration is a humanitarian goal. An important aspect of integration is the concept of social capital, attributed to Bourdieu in 1985, and subsequently defined by the Organisation for Economic Co-operation and Development (OECD) as "networks that share values and norms, allowing units to cooperate both between and within units" [8, p. 102]. Social capital also includes institutions, relationships, attitudes and values that govern interactions among people and contribute to economic and social development [16, p. 4]. Bridging social capital, or the connections made across groups with different races, classes, religion, or other qualitative differences, is especially important in this case study, as it helps community newcomers make connections and facilitates integration [10].

Historically, surveys have been a common method used to measure social capital. More recently, technological advancements have made mobile phone data a viable option for measuring social connectivity in populations (examples abound). Call-detail records (CDRs) measure call frequency from a specific caller to callee. Here, we use a CDR dataset provided by Türk Telekom, via the Data for Refugees (D4R) Challenge. These data were provided to researchers after an online call for proposals in 2018.

Proposals had to be pre-screened and approved by a Scientific Committee and a Project Evaluation Committee that was formed with representatives from academia, government, and related NGOs. No personally identifiable information was included in the dataset and Türk Telekom customers consented to the anonymized use of their data for research purposes during purchase of the phone line. Likewise, the datasets and user ID numbers were randomized so that the highest level of data was only available for a sample of users for two weeks at a time. Data for users that were sampled over the entire study period had much less detail. Customers were identified as refugees if they had ID numbers given to refugees in Turkey, registered with Syrian passports, or used special tariffs reserved for refugees [24].

We measure the number of calls between refugees and Turks, and use this measure as a proxy for economic and social integration. The ability to geo-locate CDR data also allows for insight into the environments within which heightened social capital exists. In turn, these environments suggest supporting infrastructure and geographic variables that aid refugee integration. Connecting demographic and socio-environmental data to the regions with a prevalence of social capital also allows for insight into community profiles that promote integration.

Using the CDR data, we define a subset of the Turkish population, called "active Turks", who are actively contributing to the bridging social capital by calling refugees often. (We do not have geospatial information on Turks who are being called often by refugees). We view this subset of subscribers as a separate group from other Turks, and given this distinction, we seek to compare the two groups. Using GIS data, we then compare surrounding environmental variables and nearby facilities of the two groups in order to gauge whether those who interact more with the refugee population might be doing so in correlation with spatial features such as schools and places of worship, or other features such as proximity to the Syrian border. We also examine the geographies of refugees who are calling Turks often, vis-a-vis those who are not. A group of "active refugees" who are calling Turks often was also defined in this study, and we

compare the geographic whereabouts of this group to the typical refugee.

2 BACKGROUND

2.1 Refugee Integration

Ager and Strang [1] define a conceptual framework of refugee integration that includes means and markers, social connections, facilitators, and foundation. However, many existing integration metrics focus only on aspects of segregation such as evenness, exposure, concentration, centralization and clustering [23]. Each of these metrics is a function of population proportions across areal units and none of them take into consideration the social connection domains. Their dependency on the definition of an areal unit can have adverse effects as well. Gerrymandering or strategy-driven area definitions can further complicate the already difficult process of reducing the complex concept of integration to a metric. Likewise, using indices of aggregate spatial areal units hides the process of integration at a fine grained personal level [13]. We propose a proxy of refugee integration through their call frequency to and from Turks along with the creation of individual activity spaces. This usage of CDR data reduces areal definition bias and allows us to study the effects of socio-economic variables on specific individuals, much more in line with the integration domains of social connection.

2.2 CDRs and Humanitarian Research

Studies of refugee use of information and communication technologies (ICTs) target different stages of the refugee lifecycle, each with associated information needs and use environments [21]. The lifecycle is a simplified view of a complex process that includes fleeing, applying for asylum, temporary asylum, and integration. This integration could be into the host society or to a new country for resettlement, or could materialize as repatriation to their home country.

In their research with resettled refugees in Australia, Alam and Imran [2] find that ICT use supports social inclusion. The authors recommend Australian policies, explicitly support programs, to bring refugees across the "digital divide" in the interest of warding off the social isolation associated with resettlement. Research also has investigated support for refugee integration through mobile phones [4, 5] and social media [26]. These studies find that, in South Africa, refugees' use of mobile phones has a greater role in maintaining social capital with home-country nationals rather than the local community [4]. Conversely, in Canada, resettled Syrian refugees were found to use social media to connect both with Syrian nationals as well as Canadians [26].

Other researchers have used this particular dataset to learn more about the plight of refugees in Turkey. The CDR data has been used to measure refugee access to resources, via their average distances from education and health services. It was found that these services were typically centered around refugee socialization areas rather than homes and that they could be more evenly distributed to reach more refugees [3, 22]. Refugee employment levels were approximated with calls during business hours and were found to be equal across different regions [6]. Sterly et al. [25] found that refugees prefer to live in bigger cities and that social integration is

typically higher within them. Likewise, areas with more refugees saw greater integration while tourist areas had worse evenness [7]. Border communities seemed to be much less integrated and consequentially more segregated [15]. In terms of mobility, refugees are moving from south to north and east to west, but there is still a high degree of circular movement [25]. In this data set, it was shown that most refugees lived in one location throughout the year [25] although mobility can also be significantly affected by seasonal work such as local harvests [9]. Hu et. al [17] overlaid Foursquare points of interest data to investigate refugee integration. They found behavioral differences between refugees and Turks, concluding that refugees avoid high end expenses like fashion and automobile shopping and that refugees move shorter distances in general.

2.3 Defining Social Capital

Here, we use a definition of social capital that includes the structural component including social networks, and the cognitive and attitudinal component comprised of shared norms, trust, and reciprocity [19]. Coleman [11] defines social capital as resources used by actors to identify their interests [11, p. 305]. Putnam [?] further developed social capital into two subsets referred to as bonding social capital and bridging social capital. Bonding capital refers to the connections made within communities, groups, or organizations while bridging capital refers to connections made across them. Bridging social capital will often connect individuals with different qualitative backgrounds, such as race, class, or religion [10].

Another form of social capital is linking social capital, in which individuals who belong to certain groups, organizations, institutions, etc. can reap the benefits of their membership by being connected to others and to resources through the organization.

We assume that links between Turkish natives and Syrian refugees represent instances of bridging social capital. However, we do not necessarily have proof that the outcomes of phone calls will lead to benefits for either party. Still, it has been shown that when natives know a migrant personally, they are more likely to have a stronger proclivity to accept migrants, compared to those who are not acquainted with migrants [14].

3 DATASET AND METHOD

A three-step process was implemented in order to analyze the characteristics of the social capital in Turkey most conducive to integration. First, a set of mathematical network indicators was developed in order to quantify evidence of integration, and "active" Turks contributing the most to integration. Second, these indicators were spatialized and embedded into the GIS environment and layered upon socio-environmental data. Third, integration indicators were statistically correlated with the surrounding landscape.

3.1 CDR Dataset Characteristics

This section describes the dataset used. Data comes from Türk Telekom, via the Data for Refugees (D4R) Challenge. This dataset consists of anonymized Call Detail Records (CDRs) of over 61 million calls between nearly 3 million users. Data were collected from January 2017- December 2017. This dataset is at the spatial level of the base transceiver station and tracks a randomly chosen group of

users to make phone calls and send texts over two weeks. After two weeks, a new set of users is selected. Overall, 2,782,683 randomly selected unique callers were observed, including 2,288,700 Turks and 493,983 Refugees. Combined, these callers placed 61,277,260 calls (Table 1) (Figure 1).

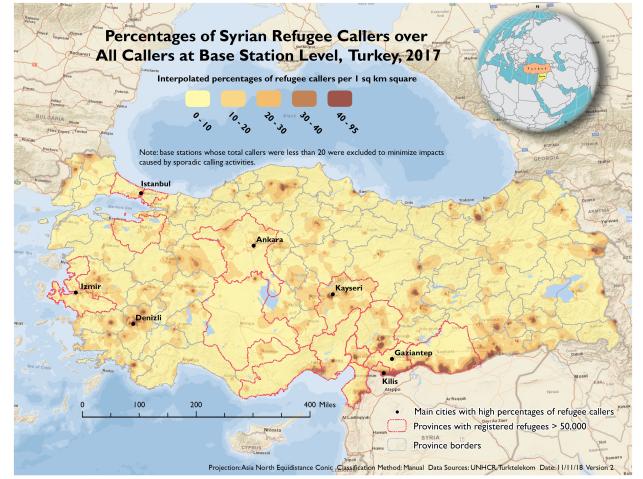


Figure 1: Refugee call locations in Turkey, at the base station level.

The data include caller ID, timestamp, callee prefix, site ID, and call type. Actual phone numbers are replaced with a unique ID, starting with 1 if the caller is a refugee, 2 for a Turkish native, and 3 if unknown. The callee prefix reflects this same pattern, although identifiers are not unique and can only be identified as either 1, 2, or 3.

On average, refugees made 12 calls while Turks made 24 calls over the two week periods. Most refugee calls went to Turks while Turks placed most of their calls to other Turks, suggesting more bridging social capital within the refugee population and more bonding social capital within the Turkish population. (However, this pattern could emerge because there were many Turks in the data sample.) Nevertheless, only 0.00972 % of calls in the total Turkish population went to refugees. Of the two million Turks in this study, only 287, or 0.0125% of the total sample of nationals placed 10 or more calls to refugees. Refugees called Turks, on average, 5.499 times, and other refugees 0.416 times. The maximum bound of calls from a refugee was 944 calls (placed to Turks), indicating that perhaps there were multiple people involved or that the phone was tied to a business or group. Turks called other Turks on average 13.35 times per period, and refugees 0.00972 times. At the maximum, one Turk called refugees 224 times.

These 287 Turkish callers who placed 10 or more calls to refugees were classified as "active" callers. Only 5% of the Turkish callers reached this call threshold. This group of individuals is thought to be leading bridging capital initiatives. They make 28,288 calls to other Turks, 6,170 to refugees, and 4,587 to unknown callees. In parallel, the top 5% of refugees who placed calls to Turks placed at least 50 calls to Turks during the two-week period. This amounts

Table 1: Call Totals by Caller and Callee Type

To/From	Refugee Caller	Native Caller
Refugee Callee	205,547	22,256
Turkish Native Callee	2,716,038	30,556,542
Unknown Callee	2,875,718	24,901,159

to 9,769 'active' refugees, whom we also consider in this analysis and report on the results below.

3.2 Analysis Method

To simulate the geographic environment, we use data on Points of Interest (POIs) and of Syrian border crossing sites sourced from the Humanitarian Open Street Map (OSM) Team. The POIs used in this study were chosen to facilitate social interactions among groups, and include: community centers, places of worship, schools, and social centers/facilities. Places of worship were further classified as Christian, Christian-Catholic, Christian-Orthodox, Muslim, and Muslim-Sunni. Distance to crossing sites and refugee camps was measured in meters using Euclidean distance. We use Turkish refugee camp sites sourced from the UNHCR and the The Regional Information Management Working Group-Europe. Analysis was conducted in ArcMap, and in the R Statistical Computing Environment.

We conducted sensitivity analysis to determine how many cell base tower locations should be included in order to capture a caller's activity space. Each individual's call locations (base stations) were ranked by frequency of calls. We found that the number of locations needed to capture an average active Turk and an average refugee's mobility and activity space sizes differs. To capture near 100% of movement of an active Turk, about 125 locations are needed. To capture nearly 100% of movement for refugees, only about 50 locations is needed (Figure 2). For active Turks, 80% of calls occur around their top 40 most frequented locations, and for refugees, the same percentage of calls (80%) occur at a mere top 10 most frequented locations.

Given this sensitivity analysis, each Turkish caller's top 40 call locations were mapped with a buffer, and dissolved to create individual activity spaces, or the local area an individual moves throughout the course of their daily activities. Each refugee's activity space was defined using the top 10 most frequent locations. The size of the buffer was 1.6 kilometers around each base station location [12]. Each individual's buffer was layered with spatial data on socio-environmental variables and distance to refugee camps in Turkey and Syrian border crossing sites (Figure 3). Through spatial joins, each individual's activity space was intersected with different types of POIs, and distance to the border and distance to camps was calculated from the edge of the activity space. These spatial statistics were conducted for the active Turks and active refugees and then for five random samples of 287 Turks and 9769 refugees taken from the entire sample of Turkish / refugee callers to serve as comparison groups with the active Turk or active refugee population.

Two-sample t-tests were used in order to assess whether there was a true difference in means between the number of POIs in callers' activity spaces for the comparison group and group of

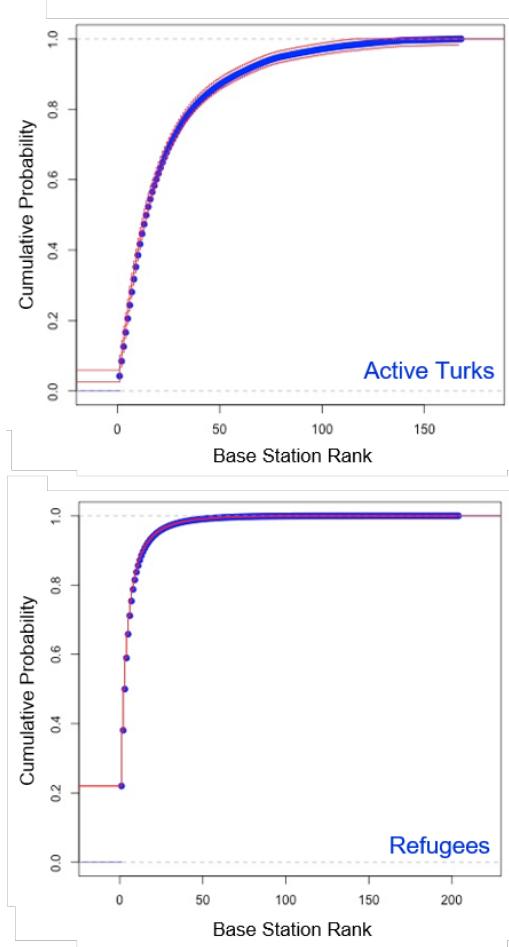


Figure 2: Cumulative density functions show how many base station locations comprise a certain percentage of total towers visited. Active Turks (top) visit more base station locations than the typical active refugee (bottom).

active callers. The null hypothesis is that there is no difference in means between the number of variables in each caller's activity space for both groups; the alternative hypothesis is that there is a difference in means between the number of variables in each group. Separate tests were performed for each variable. Statistical correlations between integration metrics and socio-environmental variables were then assessed in order to determine which spatial elements in the environment are most significantly associated with integration. The level of significance for all tests was $p = .05$.

4 RESULTS

Of the five significance tests for a difference in means between the comparison groups and active Turks, the following independent variables: *places of worship, schools, community centers, and social centers/facilities* were found to have a statistically significant difference (Table 2).

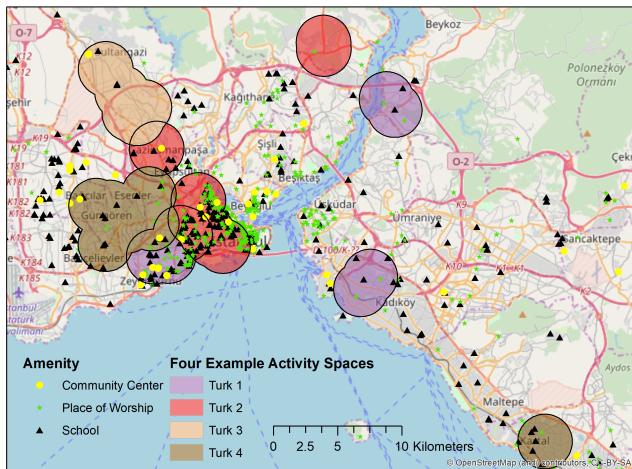


Figure 3: Example extent of four activity spaces overlaid with points of interest (schools, places of worship and community centers) in Istanbul. Points and basemap data provided by Open Street Map.

Active Turks had an average of 40 places of worship in each of their activity space while the five sample groups had an average ranging from 12-19 places of worship. Active Turks had an average of 37 schools in their activity spaces while the sample group averages ranged from 14-23 schools. Community centers per activity space averaged six for active Turks while sample groups averaged around three to five community centers per activity space. Social centers/facilities averaged around 10 per activity space for active Turks while averaging around three to five for the sample groups. The p-values for the majority of trials for variables found significance largely surpassed the .05 level. The sample groups had nearly 50% of the specified POIs in their activity spaces as active Turks did, with the exception of community centers, for which the active Turk group and the random sample had the most similar results.

The differences in prevalence of places of worship between the two groups prompted further analysis as to what types of worship along with what predominant religions were most frequent in the group of interest's activity space. We note that about 98% of Turkish residents are Muslim. The religion class with the highest number of places of worship was Muslim, at an average of 14 for active Turks and 5-7 for the sample group. Muslim-Sunni was the second highest religion class, at 11 for the group of active Turks and 3-5 for the sample group. These two religion classes along with the Christian religion class were statistically significant for a difference in means between the two groups; the difference in means for the Christian religion class was around 4 for the group of active Turks and about 1 for the sample group. Both Christian-Catholic and Christian-Orthodox religion classes had nearly the same count per activity space between groups; the average count for each group was less than one for all trials—yielding a less reliable sample, as few Turks are Christian and churches may be left over from the past.

Table 2: Results of T tests comparing active Turks' to sample Turks' number of POIs and distance to features.

Trial	Active Turk Mean	Sample Mean	P-Value	T-Value
Places of Worship				
1	39.99	16.17	9.05e-08	5.43
2	39.99	15.58	9.9e-09	5.86
3	39.99	19.05	2.141e-06	4.80
4	39.99	12.39	2.598e-11	6.90
5	39.99	19.36	2.492e-06	4.77
Schools				
1	37.67	19.14	6.283e-06	4.57
2	37.67	18.49	9.354e-07	4.98
3	37.67	21.63	9.178e-05	3.94
4	37.67	13.96	2.094e-10	6.55
5	37.67	23.07	0.0003	3.60
Community Centers				
1	6.31	4.08	0.0001	3.94
2	6.31	4.26	0.0002	3.77
3	6.31	4.31	0.0004	3.58
4	6.31	3.45	2.158e-07	5.35
5	6.31	4.50	0.0009	3.33
Social Centers/Facilities				
1	9.71	4.28	1.722e-08	5.92
2	9.71	4.13	1.602e-10	6.83
3	9.71	4.66	1.204e-08	5.98
4	9.71	3.27	4.182e-13	7.93
5	9.71	4.24	1.604e-10	6.82
Distance to Refugee Camps (Kilometers)				
1	412.11	421.85	0.67	-0.42
2	412.11	376.65	0.12	1.53
3	412.11	413.12	0.96	-0.04
4	412.11	370.51	0.07	1.78
5	412.11	427.13	0.51	-0.65
Distance to Border Crossing Sites (Kilometers)				
1	476.79	495.52	0.45	-0.74
2	476.79	443.61	0.18	1.31
3	476.79	483.58	0.78	-0.26
4	476.79	437.21	0.12	1.54
5	476.79	496.17	0.43	-0.77

The independent variables distance to border crossing sites (meters) and distance to refugee camps (meters) did not yield statistically significant results for any of the five trials. Active Turks lived in distinct locations that did not always correlate with high refugee or Turkish populations, but were found in Istanbul and near the Syrian border (Figure 4).

We repeated the analysis for the active refugee population, i.e. those refugees who often call Turks, and found that there was less statistical significance with these results (Table 3). Distance to places of worship, schools, community centers and facilities was not statistically different for refugees that often called Turks and the typical refugee. However, refugees that called Turks often were, on average, further from the border than the typical refugee, indicating that the creation of social capital happens more frequently after

Table 3: Results of T tests comparing active refugees to sample refugees' number of POIs and distance to features.

Trial	Refugees Mean	Sample Mean	P-Value	T-Value
Places of Worship				
1	16.60	17.38	0.14	-1.46
2	16.60	16.54	0.92	0.10
3	16.60	16.08	0.32	0.99
4	16.60	16.97	0.49	-0.70
5	16.60	16.56	0.94	0.07
Schools				
1	19.35	18.98	0.52	0.64
2	19.35	18.82	0.35	0.93
3	19.35	18.46	0.12	1.57
4	19.35	19.45	0.85	-0.19
5	19.35	18.42	0.10	1.65
Community Centers				
1	3.59	3.52	0.30	1.04
2	3.59	3.42	0.01	2.55
3	3.59	3.53	0.33	0.98
4	3.59	3.47	0.06	1.88
5	3.59	3.79	0.00	-2.81
Social Centers/Facilities				
1	5.76	5.76	0.99	0.01
2	5.76	5.49	0.07	1.83
3	5.76	5.52	0.11	1.60
4	5.76	5.73	0.85	0.19
5	5.76	5.52	0.11	1.59
Distance to Refugee Camps (Kilometers)				
1	358.29	389.98	6.58e-15	-7.80
2	358.29	388.46	1.16e-13	-7.43
3	358.29	388.66	9.20e-14	-7.46
4	358.29	390.57	2.33e-15	-7.93
5	358.29	376.01	1.43e-05	-4.34
Distance to Border Crossing Sites (Kilometers)				
1	420.45	457.04	2.2e-16	-8.24
2	420.45	455.40	3.77e-15	-7.87
3	420.45	455.35	4.97e-15	-7.83
4	420.45	456.83	3.44e-16	-8.16
5	420.45	457.30	2.2e-16	-8.28

refugees move from the border into more stable living conditions. This result is likely driven by a lack of Turks close to the Syrian border, and perhaps not by the nature of the relationships near the border.

In terms of distance to points of interest, refugees are also closer than native Turks to places of worship, schools, community centers and social centers, which may be beneficial for their development, access to services, and integration into the Turkish society.

5 DISCUSSION

In this study, we attempted to find whether Turks who were creating bridges with Syrian refugees tended to be located near certain facilities. We found that, indeed, these 'active' Turks were located closer to places of worship, schools, community centers, and social



Figure 4: Locations of active Turkish callers by district. Numbers represent the number of active callers in the district. Note that many callers are in Istanbul and near the Syrian border in the Southeast.

centers/facilities. Of these, places of worship posed a very significant difference—especially for Muslim and Sunni Muslim places of worship (Masjids), followed by Christian places of worship. This finding leads us to believe that Mosque communities may be helpful institutions for facilitating integration between the Syrians and Turks. As some individuals in Western countries voice anti-Muslim sentiment, it may be interesting to consider the role of their religion and belief system in helping community members (who, notably, share the same religion).

Still, the data used here presents various possible measurement issues that preclude the case study's generalizability. First, a group of users is only observed for a two-week period in order to protect privacy (a fresh sample of active users is drawn at random at the end of each two-week period) and new, random identifiers are chosen in each time period as well. This limits the time frame from which we can observe behavior. Moreover, we recognize the sample of active Turks is quite small, and a larger sample of active Turks may produce different results. In addition, the chosen buffer size for the individuals' activity spaces could be revisited using a different radius, which could produce different results as well.

There is also a possible mismatch between the sociological theory and what the dataset can tell us. Equating calls with social capital can be problematic, as calls could be for a number of purposes that do not necessarily enhance an individual's resources or opportunities, but may be part of a temporary situation, like securing housing for the week. Information on the duration of these reciprocal calls, or on the topics of discussion and their impact on the parties, could provide a stronger argument for using calls as an indicator of social capital. However, such data raise privacy concerns.

Furthermore, the process in which users are labeled as non-refugees or refugees is not entirely clear—but is said to be linked to sim card distribution; that said, it is possible that there is some

mismatch where Turks are marked as refugees, and vice versa. As with other single-carrier CDR datasets, these data only represent that of Türk Telekom, while there are multiple operators in Turkey. These data are also aggregated at the cell phone tower level, and while this is an industry standard and protects individual privacy, there may be a lack of precision in this spatial level, as cell towers can re-route calls to other towers upon call saturation.

Broadly, while CDR patterns are not reflective of all networking efforts, these findings still also suggest that phone-based connections are minimal. Face-to-face communication is another important alternative that was not considered in this study. Pinpointing the prevalent characteristics of the few Turks that are contributing to bridging social capital between refugees and natives could provide insight to governments or policymakers on strategies and features that could be useful to aid refugee integration. Hopefully, the patterns found could be applied or considered in other refugee situations. In the future, we plan to experiment with different measures of integration and compare findings with others who are conducting similar experiments.

Our analyses contribute quantitative evidence supporting the well-established findings of qualitative studies on the role of social institutions in refugee integration. However, to the extent that systematic quantitative evidence can embolden those seeking to harm either those providing assistance or refugees themselves, these findings can be considered sensitive.

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REFERENCES

- [1] Alastair Ager and Alison Strang. 2008. Understanding Integration: A Conceptual Framework. *Journal of Refugee Studies* 21, 2 (04 2008).
- [2] Khorshed Alam and Sophia Imran. 2015. The digital divide and social inclusion among refugee migrants: A case in regional Australia. *Information Technology & People* 28, 2 (2015), 344–365.
- [3] M. Tarik Altuncu, Ayse Seyide Kapitaner, and Nur Sevencan. 2019. Optimizing the Access to Healthcare Services in Dense Refugee Hosting Urban Areas: A Case for Istanbul. In *Guide to Mobile Data Analytics in Refugee Scenarios*, Albert Ali Salah, Alex Pentland, Bruno Lepri, and Emmanuel Letouzé (Eds.). Springer, Chapter 20, 403–416.
- [4] Kasky B Bacishoga, Val A Hooper, and Kevin A Johnston. 2016. The role of mobile phones in the development of social capital among refugees in South Africa. *The Electronic Journal of Information Systems in Developing Countries* 72, 1 (2016), 1–21.
- [5] Kasky Bisimwa Bacishoga and Kevin Allan Johnston. 2013. Impact of mobile phones on integration: The case of refugees in South Africa. *Journal of Community Informatics* 9, 4 (2013), 1–12.
- [6] Michiel A. Bakker, Daoud A. Piracha, Patricia J. Lu, Kein Beijo, Mohsen Bahrami, Yan Leng, Jose Balsa-Barreiro, Julie Ricard, Alfredo J. Morales, Vivek K. Singh, Burcin Bozkaya, Selim Balcisoy, and Alex àžSandýàž Pentland. 2019. Measuring fine-grained multidimensional integration using mobile phone metadata: the case of Syrian refugees in Turkey. In *Guide to Mobile Data Analytics in Refugee Scenarios*, Albert Ali Salah, Alex Pentland, Bruno Lepri, and Emmanuel Letouzé (Eds.). Springer, Chapter 7, 123–140.
- [7] Jeremy Boy, David Pastor, Marguerite Nyhan, Daniel Macguire, Rebeca Moreno Jimenez, and Miguel Luengo-Oroz. 2019. Towards an Understanding of Refugee Segregation, Isolation, Homophily and Ultimately Integration in Turkey Using Call Detail Records. In *Guide to Mobile Data Analytics in Refugee Scenarios*, Albert Ali Salah, Alex Pentland, Bruno Lepri, and Emmanuel Letouzé (Eds.). Springer, Chapter 8, 141–164.
- [8] Keeley Brian. 2007. *OECD Insights Human Capital How what you know shapes your life: How what you know shapes your life*. OECD publishing, Paris, France.
- [9] Fabian Bruckschen, Till Koebe, Melina Ludolph, Maria Francesca Marino, and Timo Schmid. 2019. Refugees in undeclared employment: A case study in Turkey. In *Guide to Mobile Data Analytics in Refugee Scenarios*, Albert Ali Salah, Alex Pentland, Bruno Lepri, and Emmanuel Letouzé (Eds.). Springer, Chapter 17, 329–346.
- [10] T Claridge. 2018. What is bridging social capital? *Social Capital Research & Training* (2018).
- [11] JS Coleman. 1990. *Foundations of Social Theory*. Belknap Press of Harvard University Press, Cambridge, MA.
- [12] Jennifer Dill. 2004. Measuring network connectivity for bicycling and walking. In *83rd Annual Meeting of the Transportation Research Board, Washington, DC*, 11–15.
- [13] Otis D. Duncan and Beverly Duncan. 1955. A Methodological Analysis of Segregation Indexes. *American Sociological Review* 20, 2 (1955), 210–207.
- [14] John H Fleming, Neli Esipova, Anita Pugliese, Julie Ray, and Rajesh Srinivasan. 2018. DATA-SURVEY: Migrant Acceptance Index: A Global Examination of the Relationship Between Interpersonal Contact and Attitudes toward Migrants. *Border Crossing* 8, 1 (2018), 103–132.
- [15] Erika Frydenlund, Meltem Y. Adener, Ross Gore, Christine Boshuijzen-van Burken, Engin Bozdag, and Christa de Kock. 2019. Characterizing the mobile phone use patterns of refugee hosting provinces in Turkey. In *Guide to Mobile Data Analytics in Refugee Scenarios*, Albert Ali Salah, Alex Pentland, Bruno Lepri, and Emmanuel Letouzé (Eds.). Springer, Chapter 21, 417–431.
- [16] Christiaan Grootaert and Thierry Van Bastelaer. 2001. *Understanding and measuring social capital: A synthesis of findings and recommendations from the social capital initiative*. Vol. 24. World Bank, Social Development Family, Environmentally and Socially Sustainable Development Network. 31 pages.
- [17] Wangsu Hu, Ran He, Jin Cao, Lisa Zhang, Huseyin Uzunalioglu, Ahmet Akyamac, and Chitra Phadke. 2019. Quantified Understanding of Syrian Refugee Integration in Turkey. In *Guide to Mobile Data Analytics in Refugee Scenarios*, Albert Ali Salah, Alex Pentland, Bruno Lepri, and Emmanuel Letouzé (Eds.). Springer, Chapter 11, 201–221.
- [18] Kristina Jovanovski. 2013. Syrian Refugees Who Were Welcomed in Turkey Now Face Backlash. <https://www.nbcnews.com/news/world/syrian-refugees-who-fled-turkey-face-backlash-n978831>
- [19] Marta Kindler, Vesselinata Ratcheva, and Maria Piechowska. 2015. Social networks, social capital and migrant integration at local level. European literature review. *Institute For Research Into Superdiversity* 6 (2015).
- [20] Kemal Kirisci, Jessica Brandt, and M Erdogan. 2018. Syrian refugees in Turkey: beyond the numbers. <https://www.brookings.edu/blog/order-from-chaos/2018/06/19/syrian-refugees-in-turkey-beyond-the-numbers/>.
- [21] Carleen Maitland. 2018. *Digital Lifeline?: ICTs for Refugees and Displaced Persons*. MIT Press, Cambridge, MA.
- [22] Marco Mamei, Seyit Cilasun, Marco Lippi, Francesca Pancotto, and Semih Tümen. 2019. Improve Education Opportunities for Better Integration of Syrian Refugees in Turkey. In *Guide to Mobile Data Analytics in Refugee Scenarios*, Albert Ali Salah, Alex Pentland, Bruno Lepri, and Emmanuel Letouzé (Eds.). Springer, Chapter 19, 381–402.
- [23] Douglas S. Massey and Nancy A. Denton. 1988. The Dimensions of Residential Segregation. *Social Forces* 67, 2 (1988), 281–315.
- [24] Albert Ali Salah, Alex Pentland, Bruno Lepri, Emmanuel Letouzé, Patrick Vinck, Yves-Alexandre de Montjoye, Xiaowen Dong, and Özge Dağdelen. 2018. Data for Refugees: The D4R Challenge on Mobility of Syrian Refugees in Turkey. *arXiv preprint arXiv:1807.00523* (2018).
- [25] Harald Sterly, Benjamin tzold, Lars Wirkus, Patrick Sakdapolrak, Jacob Schewe, Carl-Friedrich Schlessner, and Benjamin Hennig. 2019. AROMA_CoDa: Assessing Refugees' Onward Mobility through the Analysis of Communication Data. In *Guide to Mobile Data Analytics in Refugee Scenarios*, Albert Ali Salah, Alex Pentland, Bruno Lepri, and Emmanuel Letouzé (Eds.). Springer, Chapter 13, 251–263.
- [26] Luisa Veronis, Zac Tabler, and Rukhsana Ahmed. 2018. Syrian refugee youth use social media: Building transcultural spaces and connections for resettlement in Ottawa, Canada. *Canadian Ethnic Studies* 50, 2 (2018), 79–99.