Technology Literacy in Poor Infrastructure Environments: Characterizing Wayfinding Strategies in Lebanon

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ABSTRACT

While HCI for development (HCI4D) research has typically focused on technological practices of poor and low-literate communities, little research has addressed how technology literate individuals living in a poor infrastructure environment use technology. Our work fills this gap by focusing on Lebanon, a country with longstanding political instability, and the wayfinding issues there stemming from missing street signs and names, a poor road infrastructure, and a non-standardized addressing system. We examine the relationship between technology literate individuals' navigation and direction giving strategies and their usage of current digital navigation aids. Drawing on an interview study (N=12) and a web survey (N=85), our findings show that while these individuals rely on mapping services and WhatsApp's share location feature to aid wayfinding, many technical and cultural problems persist that are currently resolved through social querying. We discuss our results in light of problems that any map user encounters in poor infrastructure environments.

Author Keywords

HCI4D; ICT4D; Lebanon; navigation; wayfinding; mapping services; giving directions; addressing; strategies; mobile

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

In 2013, Google Maps[1] was estimated as the most globally used smartphone app [12]. Indeed, consumer mobile navigation and mapping technology have become quite advanced in the last decade, and almost an indispensable part of daily life. But to what extent does this hold true for developing

[1]https://maps.google.com; last retrieved: 22.5.2016

nations? In this paper, we take a close look at Lebanon, a developing country for which such technology has not specifically been designed. In present day Lebanon, the country again lacks basic infrastructure, including missing street signs, street names, a confusing road infrastructure, and a non-standardized addressing system.

Developing nations do not have sufficient infrastructure, both physical and institutional, nor a self-sustaining economic system [37], to which much of our navigation and mapping technological advances depend on. Of the currently estimated 198 countries [38] in our world, an estimated 154 are still considered developing [24], in part due to a lack of developed infrastructure. Over the recent years, the HCI community has woken up to the realities of developing countries, and witnessed increasing attention to Human Computer Interaction for development, or HCI4D [28, 40, 30, 26]. While initially the focus was on infrastructure-rich settings, and specifically on issues relating to the digital mission of access anytime, anywhere [22], recent research ranges from focusing on qualitative exploratory fieldwork for technology practices in infrastructure-poor settings [2, 16, 41], introducing new tools in such communities [15, 18], to quantitatively assessing knowledge sharing in location-based social Q&A [21].

Indeed, a recurring common denominator among HCI4D and ICT4D research has been a deep, often ethnographical focus on the behaviors and technological practices of the poor, the underprivileged, and the low-literate communities, and investigated in the context of slums and rural villages. However, little HCI4D research has focused on how technology literate individuals that live in a poor infrastructure environment use technology aids in general, and digital navigation aids in particular. These so-called 'independent users' [20], are typically younger people, who can use mobile phones and/or computers without constant help from outsiders, and who can learn new tasks and functions by themselves or from peers. To fill this gap, we have chosen to zoom in on the infrastructure and navigation issues in Lebanon, and examine closely the relationship between technology literate individuals' navigation strategies and the usage of current (mobile) digital navigation aids in Lebanon. In a sense, our work attempts to build a bridge between the classic HCI4D framework that deals directly with poor, low-literate and underprivileged people and communities, and the navigation issues of concern to

mobile HCI where the role of the infrastructure in mobility plays a key role.

Lebanon is a small yet densely populated country of 10,452 km^2 [39] in South-West Asia. The country has a 200 km coastline, running North-East and South-West along the eastern shores of the Mediterranean Sea, and it has its borders with Syria and Israel. A recent United Nations 2015 report estimates a 5,851,000 [19] population size of which approximately 87% live in cities, and where additionally the total size contains an estimated 1.07 million registered Syrian refugees [31]. The country's modern history is marked by religious and political strife, which led to a succession of conflicts that culminated in the 1975-1990 civil war. Political strife continues to affect post-colonial Lebanon, which provides a setback for information, economic, and importantly basic infrastructural development (marked by daily electricity outages across the county [11]). Due to such factors, Lebanon suffers from an insufficiently developed public transport, lack of effective road systems and heavily congested roads especially during peak hours across cities in Lebanon. Concerning internet usage, an estimated World DataBank weighted average of the number of Internet users (per 100 people) in 2014 is 74.7^2 [9], however no further data is available on technology usage.

MOTIVATION & RESEARCH QUESTIONS

Given that Lebanon is a small country, geo-mapping Lebanon's streets does not pose a tremendous effort, and given that many inhabitants have internet access, one would expect that mapping services (such as Google Maps) simply work. However, our own observations, are quite different to these expectations (which are later confirmed by our participants). While Lebanon may be geographically mapped, we have observed that people living in cities there do not rely on and even mistrust mapping and navigation services for tasks such as seeking unfamiliar Points-of-Interest (POIs) and addressing tasks. Furthermore, crowdsourced mapping efforts in Lebanon are low or missing during the last 6 years, where OpenStreetMap (OSM) efforts in Lebanon show the latest user activity in 2009 [17]. Indeed, crowdsourced mapping efforts pose a challenge in developing countries, as highlighted by Ridwan et al. [25] when discussing challenges of voluntary mapping efforts (including poor internet speeds and lack of technically skilled volunteers) in Bangladesh. Given this, we sought to examine systematically the 'localness' aspect that provides a barrier in using such technology by these technology literate users, by bringing in an HCI perspective.

In this work, we are concerned with the following two-tiered research question: What kinds of navigation and addressing problems are currently faced in Lebanon, and what strategies do technology literate individuals living there employ to overcome them? We study these navigation and addressing issues in terms of two related aspects: information access and navigation strategies for finding unfamiliar POIs, and strategies for giving directions to an address. From our research question, we distill two main research objectives: first, to characterize and classify the current navigation and addressing

problems in Lebanon, and the strategies residents use to overcome them when searching for unfamiliar POIs and giving route directions to an address. Second, to study in depth the challenges and opportunities raised in using such digital navigation aids to support wayfinding and navigation practices. To tackle these objectives, we make use of both field-based interviews and a web survey method, where given the exploratory nature of our investigation, these were determined to be suitable data collection methods. Our primary contribution in this paper is to provide the HCI community with a characterization of wayfinding issues and strategies employed to overcome them in poor infrastructure environments (such as in Lebanon).

The rest of this paper is structured as follows: first we give a review of related work on wayfinding and human navigation, local information needs, and commercial addressing solutions. Next, we describe our interview study, the methods used, and summarize our main findings. We then present our survey study, details of our method, and report our findings. Thereafter, we tie in the findings from both studies into a discussion on wayfinding problems in Lebanon and their uniqueness across the developing world. Finally, we provide conclusions for our work, and define areas for future work.

RELATED WORK

Wayfinding and Navigation

Baker [4] described navigation as a method of determining the direction of a familiar goal across an unfamiliar terrain, drawing on a series of empirical studies. Navigation here comprises route-based mechanisms that involve monitoring the direction of travel and the relative distances during the different stages of a journey, and location-based mechanisms which involve checking the current position and direction in relation to distant, recognizable landmarks. Furthermore, Hirtle and Jonides [14] showed that when people use landmarks, they rely on route knowledge and survey knowledge when navigating. In this case, landmarks are defined as conceptually and perceptually distinct locations. Route knowledge is an understanding of the environment described in terms of paths between locations, and relative to locations along those paths. Survey knowledge on the other hand describes the relationships amongst locations, for example in the form of maps. In studies that empirically investigated information requirements by pedestrians for navigation, important elements included: geometric and spatial relations, compass directions, distance units, place names, descriptions of the nature of the route and landmarks.

Brown and Laurier [6], in their seminal work on automotive GPS navigation, argue that drivers should not be seen as docile as passive receivers of GPS instructions, but rather as actively interpreting, ignoring, and reusing instructions while combining this with their own route knowledge. One of the limitations relevant to us that they elaborate on is the challenge of keeping maps accurate and up-to-date, while also taking into account the complexities of roads and junctions and their alteration over time. This is in addition to sensor failures due to poor GPS signals, which can adversely affect

orientation. Relatedly, Brown and Chalmers [5], in their attempts to design systems that can adequately address tourists' needs, highlighted that a core issue for tourists is knowing where things are. From their analysis, they showed that looking at a map involves more than simply planning a route between points A and B, but rather tourists only needed to know a 'roughly correct" direction in order to wander a city.

In his work on asking directions and pedestrian wayfinding, Hill [13] highlighted the importance of personalization of information and non-verbal communication (e.g., pointing) in order to give effective directions. When comparing the effectiveness of different types of route directions in an urban environment, Tom and Denis [29] found that processing times for instructions based on landmarks were shorter than streets named after landmarks, and subsequently, later recognition of words referring to landmarks were more quickly and accurately recognized than words relating to street names. The foregoing work on wayfinding and navigation serves as an important backdrop for our studies, given that we expect people in Lebanon to rely only partially on technological aids and instead rely more on in situ social querying strategies and landmark references, given the poor infrastructure.

Local Information Needs
To discuss navigation strategies in a developing country like Lebanon, we would need to understand local information needs. While little, there has been previous work that addresses these issues across nations and cultures. Van Wart et al. [33] present the Local Ground tool, which allows local residents to document their knowledge of places using bar-coded paper maps, computer vision techniques and publicly available mapping and charting tools. These tools allow users to annotate papers, which are later scanned and aggregated online, and ultimately contribute to a rich location-based knowledge source that allows locals to influence urban planning decisions, thus serving as a local geo-spatial data collection tool.

Recent related work by Verma et al. [36] presents UrbanEye, a localization system for public transport in suburban Indian cities meant to deal with landscapes of developing regions that suffer from lack of information in Google Transit, unpredictable travel times, chaotic schedules, absence of information board inside the vehicle. To address this, they present an energy-efficient approach that combines the volatile and non-volatile landmarks using probabilistic timed automata to improve localization accuracy.

Park et al. [21] analyzed datasets from Naver KiN "Here", a mobile app for location-based social Q&A in Korea. In comparison with conventional social Q&A sites, Naver KiN "Here" had very different topical/typological patterns, where the responses exhibited a strong spatial locality, topical distributions varied widely across different districts, and a typical cluster spanned a few neighboring districts. Their study highlights for us the importance of local information needs for community Q&A, where as we see later local knowledge plays a central role in Lebanese people's navigation strategies. Importance of 'local' information needs, be it for navigation or other search scenarios, has accumulated research interests in the last years [7, 3], where recent work highlights

the in-congruency between user requirements, their location constraints in search tasks, and what existing location-based services offers users [8].

Commercial addressing solutions
Aside from Google Maps, there are a number of ingenious addressing solutions that aim to solve the addressing issues in developing nations. Most notably is What3Words[3], an addressing solution that partitions the global grid into 57 trillion 3m x 3m squares, where each square has a 3 word address that can be shared. Their geocoder engine turns geographic coordinates into these 3 word addresses and vice-versa, which allows mapping rural spaces. Relatedly, SnooCode[4] is a smartphone app geared towards Ghana, which partitions the grid into a series of alphanumeric and numeric codes and provides similar addressing functionality. Finally, recently Eddress[5] entered this space of addressing solutions, and as in SnooCode, also turns any address into a 6 character code (e.g., ABC-123) which can be shared using their service.

While these commercial solutions promise to solve the addressing problems in developing regions, they continue to face difficulties, namely: 1) not all locals in developing regions own smartphones 2) adoption and standardization takes time 3) due to fast rates of urbanization, old places get taken down in place of new ones quickly which can result in confusion and conflicting entries, so constant updating is required from the community 4) they do not necessarily solve routing problems and finally 5) GPS position inaccuracy still results in difficulties finding POIs, after reverse geocoding.

In the next section, we present our first study, where we qualitatively investigate the challenges technology literate citizens in Lebanon face when using digital mapping and navigation aids.

PART 1: INTERVIEWS
We began our research with a broad investigation into the challenges of finding unfamiliar POIs and giving and route information in Lebanon, and what the role of technology is. To this end, conducting semi-structured interviews with technology literate locals in Lebanon was an appropriate choice of method. We wanted to firstly establish whether there are navigation challenges faced by locals in Lebanon beyond our observations and anecdotal experience. Second, we wanted to understand what strategies pertaining to digital navigation aids locals were employing to overcome those challenges.

Participants
We interviewed 12 Lebanese residents (7 male, 5 female) aged between 18-35 ($\bar{x}$ = 25.6, s = 5.7), all living in Lebanon (and have lived there for at least one year). We tried as much as possible to diversify our sample of participants across age and professions in order to get a general picture of the navigation challenges they face and how they overcome them.

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[3]http://what3words.com/; last retrieved: 22.5.2016
[4]http://www.snoocode.com/; last retrieved: 22.5.2016
[5]http://www.myeddress.com/; last retrieved: 22.5.2016

Since many of our questions were focused on digital navigation aids, we ensured that all were in possession of a smartphone and were familiar with digital mapping applications (Google Maps, Bing Maps or Apple Maps) and smartphone messaging services (WhatsApp, Facebook Messenger). See Table 1 for participant details.

#	Age	M/F	Profession	Years in LB
P1	29	M	Software Developer	26
P2	33	M	Graphic Designer	12
P3	33	M	Assistant Professor	8
P4	20	F	Undergraduate Student	1
P5	22	F	Writer / Musician	10
P6	22	M	Graduate student	21
P7	35	F	HR Director	34
P8	27	M	Web Designer	27
P9	25	M	Media Editor	25
P10	18	F	Architect	18
P11	22	F	Teacher	22
P12	22	M	Exercise Instructor	22

Table 1: Demographic information of participants from the interview study. The years column shows many years each participant has spent living in Lebanon (LB).

Interviews

Interviews were semi-structured, open-ended and covered two main scenarios: (a) finding an unfamiliar POI, (b) giving / receiving route directions. The first scenario probed participants about their information needs for finding where an unfamiliar POI is (located in the well-known Achrafiyeh neighborhood), their information search strategies, what factors they take into account before planning their trip, and how they recover if they would get lost along the way. The second scenario probed participants about how they would give directions to their house (if they lived in a well known area), how they would give directions if they lived in a rural area, what difficulties (if any) they faced in the past, and what kind of route directions they would expect from others.

Interviews lasted approximately 20 - 30 minutes, depending on the scope of difficulties faced before. All interviews were audio recorded, and later transcribed and coded by the main author, with an additional review by another author to ensure inter-coder reliability. Coded transcripts were further analyzed to extract emergent themes, which we discuss below. This resulted in 6 themes that relate to the navigation and addressing issues in Lebanon: multifaceted information access strategies; multi-faceted direction giving strategies; technological reliability; language ambiguity, conventions, and technology; technological literacy; and urban / rural divides.

Interview Findings

Below we discuss the 6 interview themes that emerged.

1. Multifaceted information access strategies

Based on our participant responses concerning finding unfamiliar POIs in Lebanon, we found that there is no single dominating information access strategy. Instead, information access strategies were multifaceted, comprising several measures intermixed with technology and social solutions to ensure that a navigation task would be accomplished. These facets included: using Google Maps, a local listings and review app called WhereLeb[6], conducting a web search (either on desktop or mobile), consulting a friend, checking the location on Facebook, landmark-based navigation, driver expertise navigation, consulting locals for directions (or "social querying"). The following example of finding out where an unfamiliar POI is illustrates this multifaceted approach: P3: *"I'd start by asking my friends, and then I'd google map it. [if not on google maps?] Then I'd google its name and check online if there's an indication of what the address is."*; P4: *"Probably I'd use the maps on my phone. It has listings, so probably enough. Or I would just use google to search. [if not on google maps?] it's usually on Bing maps, or Here maps, that's what I have."*

Such strategies accounted for backup measures, in the case of a faulty or unreliable information source during the navigation task. Such recourses included in situ social querying and making phone calls to the target place whenever possible. These are exemplified by participant responses when asked what strategy they employ if they have difficulty reaching the place once they have made their journey: P8: *"I would ask the people around me on the street. I keep asking until I find out, someone must know."*; P11: *"If the location is for example Achrafiyeh or Hamra [well-known neighborhoods], then I'd go that location and I'd call them [the POI]. And I tell them for example I'm near this place, how do I reach you?"*.

2. Technological reliability

Given the variation in information access strategies, we inquired further into what factors lead participants to adopt different strategies. Issues here fell into either problems where current technology-based navigation aids were deemed unreliable, or problems where the technological aids were not immediately available. Problems surrounding technological unreliability included: outdated mapping of locations on digital maps, GPS inaccuracy, incorrect route plans, and smartphone battery life. The primary concern raised by participants was the poor accuracy of using Google Maps, which we interpreted as a combination of poor mapping and route plan provision. With respect to poor mapping, one participant states: P4: *"Maps [Google Maps] are not very well populated with information, and then it turns into basic map reading, and not just on the go."*

Another highlights the problem by recounting a situation when Google Maps failed him: P9: *"It happened to me a few times, one time we were going down from Faraya [ski resort area], and it was dark, and the maps took us to an area with rocks, and nothing else, so we were forced to go back, and then we asked some people, and then finally figured it out. So if Google Maps doesn't work, you have to ask people. Even signs in Lebanon, they are not available in all places."* Still, others highlighted clearly that if one were to use a navigation aid like Google Maps, then ensuring the availability of a fully charged smartphone [10] in addition to social availability is

important: P12: *"If I was using Google Maps, I would make sure I have my phone with me, fully charged, and I'd make sure my friends know where the place is."* Finally, some participants voiced problems with the private taxi service Uber[7], concerning the inaccuracy of GPS and the problems associated with the high street density; P2 states: *"For the driver, I'd have to call him later. Yeah so I can see where he is on the map, but I know that he's not parked near me. I call him, yes so I'm one street ahead, go back. Doesn't happen often, but happened more than once. We come to an agreement, again based on landmarks. I tell him hey you took the wrong left, or go back or so. Happened around 5 times."*

3. Multi-faceted direction giving strategies

Just as participants' information access strategies spanned multiple facets, so did strategies for providing directions. Here again, strategies combined the use of digital navigation aids and non-technological means for address provision. P2 highlights this, making it clear that this occurs specifically in the content of a developing country like Lebanon: *"Pin [Google Maps] accompanied by general description. So you get to the general area, pin will get you there. There will be a blue building, and right behind it is a blue dumpster, and if you see, you can actually pass through there. So yes, I feel it's a combination of pin plus directions, that's the way to go in this country. Btw, I'm specifically talking about Lebanon here, I wouldn't do the same in Dubai.* Likewise for P8, his strategy is to combine WhatsApp's share location feature with descriptions: *"Either I send them a location on WhatsApp. Or I tell them ask people around. In general, wherever you live, the best would be to share a location on WhatsApp, and then figure out from that point how to give directions. And since Lebanon is quite small, there isn't a place where a location doesn't have internet or wifi, you can always talk on 3G or whatever."*

Additionally, participants employed several non-technology strategies. Relying on well known landmarks was a common strategy to resolve ambiguities, as P2 states: *"I would consider the closest landmark, something that I believe is popular among people, that they know where it is, and use that as a reference, and try to guide them from there. I would mention the way traffic goes, so I would say go with traffic or against traffic, so whether you're coming by car or by foot, you'd know."* This was further necessary in cases when an earlier strategy fails, as highlighted by P6: *"I've faced difficulties before, and I've had to either wait outside the house to get them, or go to a landmark and then go from there."* P11 highlights this need for backup measures, should one strategy fail: *"[laughs] uhh, first I would give them the name of the area I live in, then I'd give names of places near me, like restaurants, a coffee shop or something like that, and then maximum if they get lost, then I can go and meet them at a place. I've also once drawn a map for a friend [laughs]. There was a highway, and you're supposed to cut from underneath it, I had to draw that [laughs again].*

Finally, an interesting strategy that emerged was to make use of self drawn maps. P9 states: *"When this happened, I made*
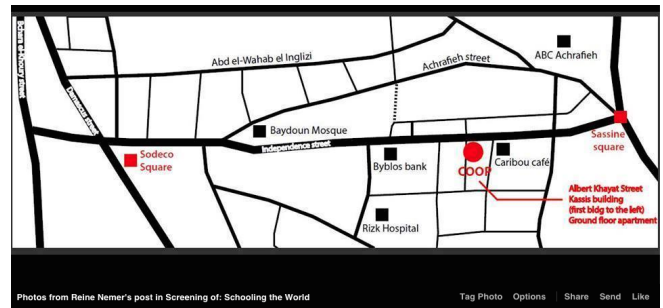
Figure 1: Facebook event map with the following address description: "Location: Going from Sodeco to Sassine, take a right on Albert Khayat street and it's the first building on your left. Ground floor"

a drawing. Exactly because its easier to know the main roads, and direction of the streets. When this happened, when I needed to invite someone, even in work events. Normally either I find a small map, but I draw it it because its easier, I draw the main street that leads to this and what are the particular places that are around and give as directions." Similarly for P10: *"I usually give directions by drawing a map of how to get there, and I send it to them."* This seems to be indeed a common strategy, exemplified by the drawn Facebook event map in Figure 1, as even event organizers are wary visitors do not get lost.

4. Language ambiguity, conventions, and technology

Another theme that emerged throughout participant responses concerned problems associated with language ambiguity and conventions. This involved two separate aspects: either the technology aid in question did not keep up with the naming conventions used by people in Lebanon, or the very language used to describe directions was highly imprecise among people. In the first case, indeed some street names were not referred to by their official names, but rather by convention – as P2 tells us: *"There is confusion. For example my street, my old street near Barbar [restaurant], they changed the name at one point, but no one knows, so they refer to it as Leon, sometimes Emile Eddie, others something different. So uhh, it's referred to mostly as Leon, but that's not what's put on the sign. Because they changed it and they don't amend the system. So if you look in Google Maps, it still says Emile Eddie, and I think now they put in brackets Leon."* Indeed, having cross-checked this fact, we find that Google Maps has indeed amended this extra piece of text to the address (Figure 2). Such a problem can pose issues to mapping services, as conventions come and go, and if mapping terms do not correspond to people's common understanding of names, then querying the maps database will not match user expectations.

For the second aspect where the language used to give directions is imprecise, P2 again highlights the severity of the issue: *"What constitutes a road or street or an alleyway, or pedestrian only pathway is unclear, so if you tell them street, they might think you can drive there when it in fact may be an only pedestrian street. So if you have a little dirt road*
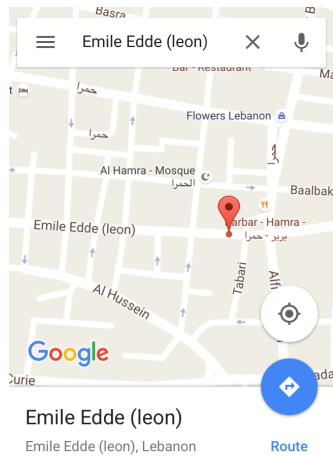
Figure 2: Google Maps appending the street name with the conventional term ("Leon") used to describe this street. Last retrieved: 22.5.2016

that you can go on by car, is that a street or a "ma'mar" as they say here? Or "mafra'a"? Especially when you get to densely populated areas like Achrafiyeh [district] or Mar Mikhael [district]. What is happening here is that the terms used are ambiguous, and do not adequately reflect the referenced object. Similarly, P7 tells us how she faced similar troubles when language and reality do not correspond: P7: *"When I say next to Salon Mike [hair salon] here in Hamra [well known street], there is an alley. But some people think it's a small road, and they think they can drive through, but actually it's an alley, you can only walk through. So you need to park outside first. So in these cases people get lost or family members not knowing how to reach there."*

5. Technological literacy

In our interviews, participants brought forth issues relating to the mismatch between technology usage and expectations from others. Whether or not the receiving party of directions to an address was technologically literate played a role in adjusting the direction giving strategy. As P12 tells: *"Yes, some people don't know how to use Google Maps or the WhatsApp thing, so I would have to tell them by mouth, by words, and sometimes they don't get it, so I'd have to go get them from there [the place they are currently at]."*

When asked about what they expect when receiving route directions, the consideration of technological literacy was additionally taken into account. P1 retells his story: *"Now I would expect a GPS coordinate. From friends definitely. From parents though, I would expect still the old way, for sure [laughs]. [do you seek this out specifically?] Yes, for sure. Sometimes, it's weird actually, I have some people who ask me how do you send a GPS coordinate from WhatsApp, and then I tell them just press this and that, it's two buttons away, not very complicated."* This need for greater technological accessibility for older generations was explicitly mentioned by P5, who told us: *"I think the smartphone is really important, Internet, 3G. It should be made more accessible I think."*

6. Urban-rural divides

A final theme that emerged was the difference in wayfinding strategies across urban-rural divides. Specifically, the shortcomings of technology-based navigation aids and how they impact information access and address provisioning in Lebanon. In our interviews, we explicitly asked participants how they would deal with situations when giving directions to an address in a rural area, which is quite common given the many villages in the mountainous regions of Lebanon. P1 tells us: *"Then this wouldn't work obviously, you'd have to go stand there. You would have to give a street name, a written address kind of thing."* P7 brings up the same issue in the context of her sister's wedding: *"It will be very hard honestly. If I think about my sister's wedding, she had to put signs starting from Kfarhim [village name] to reach Ba'aklin [village name], it's not that it's not really not popular, but she had to do it, otherwise people will get lost, because there are several villages in between."*

Without referring to a village or a rural area, P12 highlights the importance of popular landmarks: *"If you have many shops, little shops next to you and they are not known or not popular, then that's an issue. So popular landmarks are really important."* When asked about his usage of technology aids, he mentions: *"Google maps for sure. [for rural areas?] Honestly, I would have to go and pick them up."* Similarly, P9 highlights his strategy of using both technological and non-technological means to overcome addressing issues in a rural area: *"Either I send them a location on WhatsApp. Or I tell them ask people around. In general, wherever you live, the best would be to share a location on WhatsApp, and then figure out from that point how to give directions."* Despite these observations however, the urban rural divide is not necessarily specific to Lebanon, as we expect this also occurs in rural areas in developed countries that have poor network coverage.

PART 2: SURVEY

To further explore our findings from the interviews, we designed and deployed a web survey in order to collect a larger amount of quantitative and qualitative data. Given the exploratory nature of our study, a web survey served as a suitable data collection method. The survey was created in both English and Arabic. We collected basic demographics about participants, asked about information seeking strategies for finding an unfamiliar place and navigating there, and the challenges faced and how they overcome them, with a focus on the usage of mapping services. In the second part, respondents were asked behavioral questions about how they give directions to their home, the difficulties they faced, and how they overcome them. In this part, we deliberately did not ask questions concerning the technological literacy theme, as this would have been difficult to verify from a survey approach and given our recruitment criteria of familiarity with navigation aid technology.

Questions consisted primarily of checkboxes and open-ended forms, with two 7-point Likert items ($\alpha = 0.43$)[8] that asked a) whether they faced difficulties before when using a mapping

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[8]Items exhibited a low internal reliability due to the small number of items, however this should not matter as we do not provide a scale.

service and b) whether they faced difficulties before when giving directions to their home address (e.g., the person got lost). Below we describe the procedure of our web survey. These two items showed a rather small yet significant correlation ($r_s = 0.29$, $p < 0.01$)[9].

Procedure

We used homogenous sampling to recruit participants, relying on multiple channels to advertise our survey, including social media channels (Facebook[10], Twitter[11], LinkedIn[12]), online Lebanese forums, a blog post, and physical printouts pinned on billboards of two major universities in Lebanon. The requirements to participate in the survey were threefold: a) participants had to have lived in Lebanon for at least 1 year during the last 3 year period, b) were familiar with and have used a digital mapping service before (e.g., Google / Bing / Apple maps) on a smartphone, and c) were familiar with and have used a messaging application on a smartphone (e.g., WhatsApp, Facebook Messenger). Those who answered the entire survey were eligible to enter a raffle draw of three prizes worth $50 each, in the form of an electronic gift card for a popular department store there.

Participants

85 survey respondents (56 male, 29 female) living in Lebanon signed up and answered all questions in our online survey. In line with our recruitment criteria, all respondents had lived in Lebanon for at least one year ($\bar{x} = 21.6$ years, $s = 10.8$). Most of our participants were Lebanese nationals (90.6%), with the remainder spanning respondents of Syrian, Greek, American, or of mixed French Lebanese origin. Age of participants ranged from 17 to 74 years old ($\bar{x} = 27$, $s = 9.3$). All participants were familiar with digital mapping services and messaging apps on smartphones, and their usage frequency of each are summarized in Table 2.

Finally, to gain a better understanding of our respondent pool's navigation strategies, we asked which means of transport they used most often. Highest percentage of votes were to use either their own car or motorcycle (67.1%), followed by walking (54.1%) and taking a 'service' (40%), which is Lebanon's common carpool-based taxi sharing service. Worth noting here that taxis in Lebanon are not currently equipped with GPS navigation systems. Remainder of votes were to use a friend's or relative's car (31.8%), to take a normal taxi (18.8%), an Uber ride (12.9%), bicycle (3.5%), or a public transit bus (5.9%).

Survey Results

Only two respondents filled the survey in Arabic, and were thereafter translated to English. This is not surprising, as the use of Arabic in Lebanon is perceived to be less fashionable than speaking in French or English [1], which may have influenced choosing to fill out the survey in English. Below we

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[9]Spearman's rank correlation coefficient was used due to the ordinal nature of Likert items.
[10]https://www.facebook.com/; last retrieved: 22.5.2016
[11]https://twitter.com/; last retrieved: 22.5.2016
[12]https://www.linkedin.com/; last retrieved: 22.5.2016

Usage Frequency	Mapping Services	Messaging Services
Several times per day	0	54
Several times per week	10	27
Around once per week	54	2
Rarely	15	0
Never	6	2

Table 2: Descriptive statistics on usage frequency of mapping and mobile instant messaging services.

present in turn our results on finding and navigating to an unfamiliar POI, the challenges and strategies used to overcome them, and thereafter our results on how respondents give directions to an address, and the difficulties faced there.

Respondent open ended responses were complementarily analyzed in terms of document term frequency, and visualized as word clouds to aid analysis. For this analysis (using the text mining and wordcloud packages in R), punctuation, common English stop words, numbers, lower case conversion, and extra white space was removed, with additional word stemming (using Porter's stemming algorithm [32]) passed as a parameter to construct the document term matrices. Maximum allowed sparsity was set at .9 to capture the range of terms shown in the word clouds (Fig. 3).

Unfamiliar POI information seeking strategies
Respondents were asked about their information seeking strategies when they want to visit a place they have not previously been to. We used Achrafiyeh as an example, a well known area located in Beirut to ensure all respondents were familiar with the area and can answer the question. The list of strategies are summarized in Table 3. Interesting to note that despite our earlier findings on the technological limitations of mapping services, searching in mapping apps received the highest percentage votes. However, we can see that strategies are indeed multi-faceted, in that respondents rely on multiple means to find information, including calling friends or family members, performing a web search, searching in Facebook pages, and importantly finding out whether or not popular landmarks are near the place. Fewer votes mentioned just going to the area and socially querying others, but as we show later, this is a recurring information seeking strategy in Lebanon. Lastly, respondents mentioned using the whereLeb service, as it provides local up-to-date listings. Other responses included using Foursquare, Here maps, the Zawarib [42] maps (local bus route maps of Lebanon), and calling the place beforehand.

Unfamiliar POI navigation strategies
To complement our understanding of visiting unfamiliar POIs, we additionally asked respondents to tell us how they navigate to such an unfamiliar POI. Results are summarized in Table 4 and corresponding open ended responses as word clouds (sparsity: 89%) are shown in Figure 3a. By contrast to information seeking prior to making a trip to the unfamiliar POI, here respondent votes were highest for both searching in maps as well as for getting to the general area and asking locals for directions. Not surprisingly, relying on driver expertise (whether as a taxi, service, or Uber driver) to determine

(a) Difficulties faced using mapping services

(b) Strategies to overcome difficulties with mapping services

(c) Difficulties faced giving directions

(d) Strategies to overcome difficulties in giving directions

Figure 3: Word cloud visualizations of respondents' open ended responses.

Unfamiliar POI Information Seeking Strategy	Count (%)
Search in Google / Bing / Apple Maps	68.2
Find out if there are popular landmarks near the place	43.5
Call a friend or family member	40
Go to website of the place	38.8
Web search (e.g., Google)	37.6
Search in Facebook pages	31.8
Just go there and ask people	29.4
Check the whereLeb service / app	17.6
Other	7.1

Table 3: Information seeking strategies for unfamiliar POIs and percentage of respondent votes.

Navigation Strategy	Count (%)
Use Google / Bing / Apple Maps	65.9
Get to the general area and ask people around there	64.7
Get in a service / taxi and rely on the driver to know the exact address	40
Make use of street signs	21.2
Other	10.6
Use a paper map	4.7

Table 4: Navigation strategies to unfamiliar POIs and percentage of respondent votes.

the exact address was stated to be an additional strategy used. Furthermore, in line with our interview findings and observations concerning signage infrastructure in Lebanon, fewer respondent votes mention relying on street signs for navigation. Remainder of votes covered using a paper map, using the Uber service, using the in-car GPS Navigon Middle East app, going with a friend that knows the place already, querying Here maps, or calling the place beforehand.

Overcoming shortcomings of mapping services
When asked whether they experienced problems when using mapping services before, respondent responses were divided ($Md = 4$, $IQR = 3$-5), highlighting the uneven distribution of those that experienced difficulties and those that have not. Moreover, respondents differed in reported experienced difficulties with mapping services and whether they used mapping services once a week or several times a week ($p = 0.009$, FET[13]), and whether they reported rarely using such services or using them several times a week ($p = 0.02$, FET).

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[13]Fisher's exact test (with .95 CI) was computed due to small number of counts in some cells.

Difficulty faced	Count (%)
Outdated information on the map	66.3
Inaccurate position marker on the map	54.1
Incorrect or missing places on the map	52.9
Incorrect route plan	38.8
Street labels on the map do not correspond to how people talk about them	27.1
I have not faced difficulties	9.4
Other	4.7

Table 5: Difficulties experienced with digital mapping services and percentage of respondent votes.

To gain more insight, we asked respondents to tell us explicitly which factors (identified in our interview study) they experienced before that posed challenges for them when using mapping services (such as Google Maps). The percentage of votes are summarized in Table 5 and corresponding open ended responses as word clouds (sparsity: 81%) are shown in Figure 3b. One of the biggest issues respondents identified was seeing outdated information on a map, which is expected from a developing country with rapid urbanization. Next highest factors included having an inaccurate position marker on the map, and incorrect or missing place listings on the map. While GPS inaccuracy is a well known technological limitation [6], showing incorrect or missing places from the map is a crowd-sourced effort that is lacking in Lebanon.

Other highlighted issues included incorrect route plans, and a lack of correspondence between street labels and how people talk about them. While incorrect route plans do occur in developed countries, the latter seems to be unique to trilingual Lebanon (as identified earlier in our interviews when discussing language ambiguity and conventions), marked by how common it is for people to develop their own linguistic conventions for referring to places. Fewer respondents (9.4%) stated they did not face difficulties, and others attributed difficulties to poor network connectivity, incorrect bus route plans, or to maps only showing partial information (such as main roads only).

Addressing difficulties
To understand respondents' direction giving practices and difficulties, we firstly needed to identify in which district of Lebanon they lived in. Many lived in Beirut (54%), followed by Mount Lebanon (41.2%), South Lebanon (2.35%), North Lebanon (1.18%), and Beqaa (1.18%), with no responses

from the Nabatiye district. Furthermore, we asked respondents whether or not they lived in a well-known area, where more than half (63.5%) stated they did. We asked respondents whether or not they previously experienced problems when giving directions to their home to a person that has not visited before, where open ended responses as word clouds (sparsity: 81%) are shown in Figure 3c. Here again, respondent responses were divided (*Md* = 4, *IQR* = 3-5), highlighting that experiences can radically vary when giving directions.

To investigate further, we divided responses into agree, disagree, and unsure nominal categories, and analyzed whether or not living in a well known area could account for this discrepancy. However, we did not find a significant effect between living in a well known area and respondent difficulties when giving directions (χ^2 = 4.75, p = 0.09). This was surprising, as we expected to see a clear effect. To explain this, we dug into our respondents' responses into how they overcome addressing difficulties, where some responses included: *"No real difficulties, got used to it"; "You get used to it"; "For someone new to the country, I think it is very very difficult to adapt to our system. But I've got the hang of it"*. That people living in Lebanon have become attuned to the situation there could explain why respondents did not definitively state they faced problems in the past, especially when infrastructural issues and technology limitations are evident.

Some respondents explicitly mentioned poor road infrastructure: *"Roads tend to change directions"; "People not knowing correct names of roads or areas, confusion about which roads are with traffic and not against, this one is particularly dangerous since our streets are quite tight.".* Still others commented on the poor availability / awareness of street signs: *"Lack of street names, or when the street has a name, others don't usually know it"; "Limited signage indicating the street name and building numbers"*, and others highlighting the expectations from others: *"Limited cultural use of street names (street names are not recognized even by people who live on the street)"; "We've been relying on POIs for decades now - the problem being that what is a well known POI for me might be totally unfamiliar for someone else. And vice versa."*

Overcoming direction giving difficulties
We asked participants to tell us what direction giving strategies they used typically when give directions to their home address for a person who has not been there before. The percentage of vote counts are summarized in Table 6 and corresponding open ended responses as word clouds (sparsity: 86%) are shown in Figure 3d. Here, the most common strategy was to provide verbal / written directions, followed by giving a street address and number, sharing one's location on WhatsApp, and picking up the visitor(s) at a well known location. Interestingly, as was identified in the interview study, some respondents mentioned drawing their own map. Additionally, some votes covered sharing a Google Maps marker, however no votes mentioned using Facebook's share location feature. Of the remainder strategies, respondents mentioned they would ask their mother to give directions, meeting the visitor halfway, or giving directions to someone in the visitor's group that knows the area better.

Giving Directions Strategy	Count (%)
Verbal / written directions	81.2
I give my street name + number, and floor	31.8
WhatsApp share location	31.8
I pick up whoever is visiting at a well known location	30.6
I share a Google Maps marker	11.8
I draw my own map	9.4
Other	8.2
Facebook share location	0

Table 6: Giving directions strategies and percentage of respondent votes.

Together, these findings show that for giving directions, people also draw on multifaceted strategies to ensure that a visitor does not get lost, as further illustrated by these responses: *"Mainly pick up from a close address or stay on the phone till the visitor reach my place"; Send picture-by-picture of the path they're supposed to go through, or send my location via whatsapp and telling them to use their own maps application to navigate to it"; "I draw out a map or go there myself. I also might give even more detailed verbal instructions."*

DISCUSSION
Drawing on data collected from both studies, we uncovered a range of factors that pose challenges for technology literate users in Lebanon when it comes to unfamiliar POI information seeking tasks and giving directions to an address, which we discuss below.

Navigation to Unfamiliar POIs and Addressing Difficulties
In line with our observations that led to this study, we showed that many of the issues people living in Lebanon face are due to either poor infrastructure or technology not designed explicitly for such regions, wherein the latter depends on such infrastructure. This includes poor road infrastructure, missing or hidden street names, and lack of a usable, standardized addressing system in place. Due to these factors, navigation aid technology such as mobile maps and route guidance pose problems for residents in Lebanon, even though many of our respondent vote counts (68.2%) mentioned searching in mapping applications for unfamiliar POIs. Difficulties with mapping services revolved around having outdated information on the map, incorrect position marker due to GPS inaccuracy, and having incorrect or missing places on the map.

Despite such technology failures, we did not see a strong agreement concerning difficulties faced using such mapping apps. While this could have been due to cultural and environmental assimilation, where some respondents explicitly stated they have become used to the fact that these technologies do not always work in a country like Lebanon, it is however more likely that these individuals simply have a range of strategies to overcome such wayfinding difficulties. Mainly by drawing on strategies of socially querying others (who may be more familiar) about the location of a POI. Indeed, we found that for the task of finding an unfamiliar POI, people draw on multifaceted strategies that include web search, searching in mobile maps, and checking social networks, but also importantly seeking out the nearest well known landmarks (cf.,

[14]), and thereafter asking others, be they friends, family, or strangers. This aspect of asking for help (or 'social querying') in Lebanon, while a key aspect of culture there, is also not specifically unique to Lebanon.

For giving directions to an address the recipient was unfamiliar with, again we did not find strong respondent agreement that they faced difficulties, even when accounting for whether or not a person lives in a well known area. Here again, this is likely due to the range of bypass strategies these individuals have to overcome such difficulties. While strategies involved the use of technological aids such as WhatsApp's share location feature, more dominant strategies involved traditional methods of providing verbal / written directions, street names and numbers (despite their unreliability), and picking the target person up from a common location.

Wayfinding Challenges Unique to Developing Nations?
It is important to ask in development research focused on a particular nation or community to what extent can findings generalize to other communities or user groups. Sambasivan et al. [27] highlighted this issue in the context of ethnographical research, warning not only of the biases held by the researcher, but also to the interactions that occur between the researcher and informants. In our work, we narrowed our focus on technology literate individuals in Lebanon who live in an environment with poor infrastructure. Indeed, we cannot claim that Lebanon's infrastructural setting, cultural intricacies, and current development state is identical to other nations across the world, especially given Lebanon's longstanding political instability. However, are these problems faced unique to Lebanon, and if so, are some elements generalizable to other developing nations? Or are they only amplified extensions of what any map user encounters given infrastructure and technology failures?

Based on our findings, we see that at least for some infrastructural issues, such as availability and visibility of street signs and their standardization across a nation, are not necessarily unique to Lebanon, but the product of a nation undergoing infrastructural development (c.f., some parts in India [23]). On the other hand, behavioral factors that involve ambiguous and culturally-laden terms to describe locations and streets, appear to be a unique and culturally specific aspects of navigating in Lebanon. Nevertheless, the strategies people use to deal with both types of issues do not appear to be categorically different than the issues faced by technology literate users elsewhere when failures (whether in infrastructure or technology) occur. Such fallback strategies, as we have seen, involve social querying and drawing on survey and route knowledge. This is in line with previous work on the difficulties associated with driving using GPS [6], as well as the problems tourists encounter when using maps to wander in a new city [5].

Utilizing Local Knowledge
We have seen from both studies the value of local knowledge, whether drawn from service listings such as whereLeb, Lebanon specific bus transit maps such as Zawarib, POI and route knowledge of taxi / service drivers and Uber drivers, to especially people relying on locals for directions. An opportunity here lies in developing digital techniques for transferring hyperlocal knowledge, akin to the Local Ground tool by Van Wart et al. [33], and designed in an accessible way such that literacy in general is not required. This would not only preserve the social aspect and sense of solidarity of communicating with others, but also provide timely answers to bypass everyday wayfinding difficulties. An example would be to focus on voice-based user interfaces (cf., Sangeet Swara voice forum [34]), to allow users to label street names using voice commands, to which efforts are rewarded in micro-rewards.

Sampling Challenges
A major challenge we faced was acquiring survey respondents, resulting in a potentially low sample size for a survey. This may be due to many of the educated and literate do not perceive the wayfinding issues they encounter on a daily basis as a priority to be addressed. Importantly, while we opted for a lottery-based approach to incentivise individuals to respond, a better approach may have been to offer a fixed incentive to facilitate snowball sampling, where Vashistha et al. [35] showed that this spreads much faster throughout a peer network. While we considered this, currently no such accessible credit-based micropayment system exists in Lebanon. The foregoing not withstanding, our survey was used as a probe to explore behavioral factors, not to gather opinion polls, where in our case the margin of error[14] matters less.

CONCLUSIONS & FUTURE GOALS
Our work set out to investigate the navigation and direction giving strategies used by technology literate people in Lebanon. Based on two studies, our findings highlighted the multifaceted nature of navigation and direction giving strategies, that intermix technology aids with social querying to resolve ambiguities. In using such technology aids (e.g., Google Maps when searching for unfamiliar POIs or WhatsApp's share location feature for addressing), we found out that many problems persist for these users, which include outdated information on the map, incorrect or missing places and names, faulty route plans and GPS localization inaccuracies that cause frustration. Additionally, a recurring finding was the use of ambiguous and culturally-laden terms to describe locations and streets, whereby in order to overcome such difficulties, people relied heavily on the expertise of locals and queried others in situ to resolve them.

A future goal is to draw on the current findings concerning language ambiguity and local conventions in naming streets and other POIs and design around this problem (cf., the Sangeet Swara voice forum [34]). We will focus on locally adapted, voice-enabled microtasking solutions, and validate our work in the field, across technology literacy levels. This would require us to tackle both the problem of user input, as well as how to effectively represent local knowledge to aid information access in developing nations.

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[14]Estimated to be 11% given a 95% confidence interval.

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