Social Communities in Urban Mobility Systems

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Abstract. Social and traffic dynamics of mobility in urban areas can be derived from people's behavior on social networks. In this research study, we take steps towards a conceptual framework for visualizing the social and traffic dynamics of urban mobility. We present an overview of transportation modes and services that have a digital presence, and illustrate these with a number of examples, along with the information available from public and private modes of transportation. Further, we derive insights gained from investigating social media communities that are active in the scope of mobility, using Saudi Arabia as a case study. By conducting an exploratory survey of related social media communities, we describe the socio-cultural factors that were considered in the design of mobility-oriented services. We also provide insights for investigating social communities in urban mobility.

Keywords: Mobility · Transportation · Social Computing · Location Sensing · Social Network Analysis

1 Introduction

The widespread use of online social media and the ubiquity of low cost computing have increased the possibilities for understanding socio-cultural behaviors in urban mobility and the attitudes of people in transit. At the same time, these aspects have facilitated opportunities to make shared-interest social communities accessible, detectable, and comprehensible [28]. Gadgets such as smartphones, tablets, personal computers, and other GPS-enabled devices leave digital footprints of the user's activities. These proliferating digital footprints that people leave as they crisscross cities offer a treasure trove of mobility patterns and socio-cultural information [29]. This information is valuable for understating the social and traffic dynamics in an urban area and can consequently aid in city planning, policymaking, and traffic management. The individual, community, city, and regional dynamics can be extracted from the interconnected information that is readily available on social media. Despite the rapid growth in the social media presence of mobility services and communities in Saudi Arabia, the understanding of the landscape of services in the geographic region is

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inadequate and the literature on the topic is scattered across multiple disciplines [1]. This paper aims to address this issue by providing a descriptive overview of the Web landscape of mobility services and social communities.

While researchers have sought insights from communal behavior in contexts of mobility in countries across the world [2, 3], the literature is scarce on the Arab region in general and Saudi Arabia specifically. However, recent studies have shown that social media activity is rapidly growing in Saudi Arabia [4, 5]. In fact, Saudi Arabia has one of the highest penetration rates in the world when it comes to social media interactions [24]. However, it is surprising that the understanding of both the use of social media by Saudi residents and the impact of such are mostly derived from anecdotal sources (e.g. news reports and a scarce body of scholarly research on social analytics). What remains to be examined are the self-organizing urban mobility systems that have emerged in Saudi Arabia in recent years.

This research goal is to understand the transportation modes and services that have a digital presence in social media as well as the diffusion of technology in the context of urban mobility systems. More specifically, the following research questions have been formulated: What are the entities that have a digital presence, and how are they utilizing existing social media platforms? To answer these questions, an exploratory study of social communities have been conducted—contrasting privately owned and government public services—in order to understand the landscape and modes of communication of entities that are operating in the context of urban mobility in Saudi Arabia.

2 Related Work

In urban contexts, mobility is a multidisciplinary field. This research intersects social analytics, urban studies, transportation, civil engineering, planning, and policy. Prior research has often focused on each of the above separately and from a specific point of view [25–27]. This paper provides an overview of social communities of mobility from those different perspectives. The following subsection outlines Saudi Arabia as a unique context of study for social and traffic dynamics and the mobility research for examining social and traffic dynamics.

2.1 Saudi Arabia as a Unique Context of Study for Social and Traffic Dynamics

The investment in taxi service app companies has rapidly grown globally to more than $1 billion in venture capital [6]. Saudi Arabia has a population of about 30 million and has a markedly high mobile phone penetration rate reaching roughly 74 % of the country's inhabitants according to a recent report by PayFort [6, 7]. Moreover, none of Saudi Arabia's cities have a reliable metro or bus system; most importantly, almost half of the population (i.e., the female population) is not allowed to drive. Recent studies on the social traffic dynamics in Riyadh, Saudi Arabia's capital and main financial hub have provided insight into the patterns of mobility on the roads [1], an analysis conducted by

the Center for Complex Engineering Systems in their City Dynamics Project[1] on the observed movements of Riyadh's urban population provided a better understanding of the city's demographics, the distribution of amenities and services, the flow of the existing transportation networks, and the temporal and spatial dynamics of traffic in Riyadh, which was visualized in an interactive web-based platform as it shown in Fig. 1. Such platform was develop to facilitate access to these complex datasets for policy-makers and the general public.

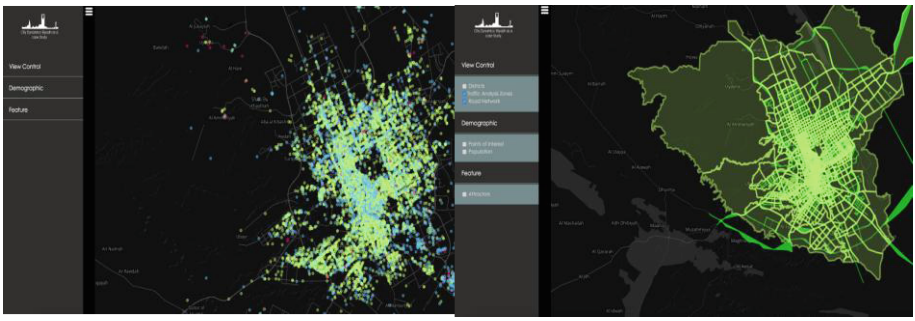

Fig. 1. City Dynamics visualization platform

In Riyadh, privately owned vehicle is the main transportation system for the urban and suburban population [8]. The Institute for Mobility Research (IFMO) study in 2015, which involved a cluster analysis from a mobility perspective of 45 cities around the world, classified Riyadh as an "auto-city" (encouraging the movement of people via private transportation) along with Houston, Texas and Phoenix, Arizona in the US [9]. Private taxi services are ground transportation technology companies that offer mobile location-based apps. These companies have rapidly scaled the transportation market in Saudi Arabia due to the perceived reliability, safety, convenience, and affordability of their chauffeur-driven vehicles. Customers track their rides in real-time, pay with credit cards, cash, or telecom-based credit systems, and access receipts online. The persistence and sense of safety associated with private modes of transportation clearly contrast with the perceived lack of reliability associated with the public transportation alternatives. Recent initiatives have sought to engage with the public by offering services to aid inhabitants in their travels within the city of Riyadh.

2.2 Mobility Research for Examining Social and Traffic Dynamics

Social analytics research has investigated the mobility patterns of populations. Early work examined individual human mobility patterns and modeled the dynamics between social media and mobility behavior [12–14]. Other work focused on investigating urban population activity and mobility patterns through social networks data [15, 20] or

[1] http://www.cces-kacst-mit.org/project/city-dynamics.

from cell phone data [21]. More recent work has focused on leveraging the ubiquity of sensors in mobile phones for monitoring road and traffic conditions [22]. In the space where people get from point A to point B, the transportation network is a rich, varied composition of mobility patterns of people and objects (vehicles). Social dynamics aim to understand people's mobility patterns, and traffic dynamics investigate the population's flow through transportation networks. This type of research and analysis is often conducted with the objective of predicting traffic conditions and providing real-time traffic and mobility indicators [12].

3 Social Media Landscape

Inspired by research methodologies developed for analyzing urban dynamic systems, this paper explored computational methods that measure various static and dynamic aspects of social networks and their relation to an underlying mobility pattern of specific demographics in a given urban area. It mainly investigated social media communities that are active and have a digital presence in the scope of mobility in Saudi Arabia. This section presents the main private mobility systems taxi services in Saudi Arabia (Riyadh in particular), some of the government-based and community-based traffic notifications systems, and some of the trends that have emerged in social media conversations about urban mobility in Saudi Arabia. Figure 2 shows a conceptual framework for classifying the social and traffic dynamics of mobility in an urban area, where systems can be classified under offline and online communities. Offline communities are government public and private mobility systems, and online communities are traffic notification systems and social networks. These communities are aligned and insights that can be gained from drilling deeper into social/traffic dynamics with analytics and visualizations.

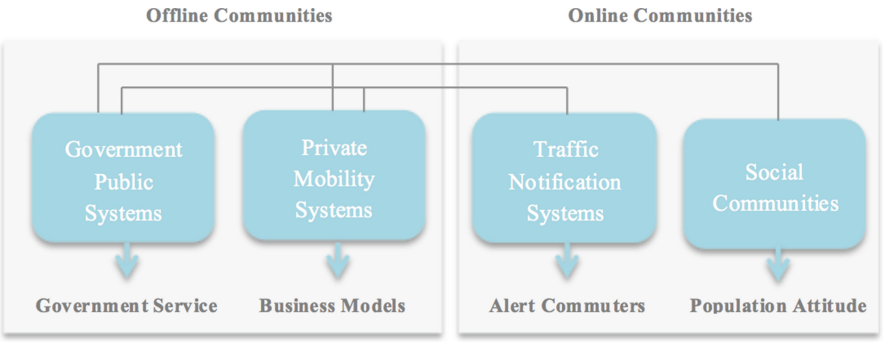

Fig. 2. Framework for visualizing the social and traffic dynamics of mobility

3.1 Privately Owned Transit Systems

The movement paths of people, which can be captured using trajectories of journeys, can represent human mobility or a sequence of events produced from the same person

within a time window (e.g., geo-tagged tweets, photos, or check-ins in social apps [10]). For example, Riyadh is the home of more than 6 million people and has witnessed a significant increase in its population [23]. Moreover, for a long time, low gasoline prices offered an incentive for people to use their own vehicles to move around. Nevertheless, the increase in gasoline prices and traffic congestion, along with the absence of a public transit system, people (especially female) has started using taxi services and self-organizing ride-sharing communities more frequently. Therefore, mobility through taxi routes as a means for sampling and gaining insight into mobility patterns in Saudi Arabia have been captured. Table 1 shows basic information about some of the most popular taxi services in Saudi Arabia.

Table 1. Taxi services' apps in Saudi Arabia

Service	Launched	Based in	Cities	Payment Method
Uber	2012	United States	Riyadh, Jeddah, Dammam	Credit Cards, Cash (Riyadh/Jeddah)
Careem	2012	United Arab Emirates	Riyadh, Jeddah, Dammam, Makkah, Madina, Al Hasa, Jubail, Qassim	Credit Cards, Cash, Saudi Telecom Company (STC) Qitaf[a]
Easy Taxi	2014	Brazil	Riyadh, Jeddah	ET pay, Credit Cards, Cash
Taxi "Aujrh"	2015	Saudi Arabia	All Cities	Cash
MyTaxi Saudia	2009	Saudi Arabia	Riyadh, Jeddah, Dammam, Makkah, Medina	Cash
Mishwar	2014	Saudi Arabia	Jeddah	Credit Cards
Mondo	2014	Saudi Arabia	Riyadh, Jeddah	Cash
Taxi Pixi	2013	India	Riyadh, Jeddah, Makkah, Abha	Cash

[a]http://www.stc.com.sa/wps/wcm/connect/english/loyaltyPrograms/tamayouz/briefOnTamayouz

Several taxi services have started to take advantage of the lack of public transit systems. One of the factors that affect the popularity of a taxi service is the method of payment. Therefore, the more popular taxi service apps in the region allow their customers to pay in cash to accommodate their preferred method of payment [12].

By looking at the mobile app market in Saudi Arabia, insight can be gain from the presence taxi services have within the transportation ecosystem. According to AppAnnie[2], a platform that provides app market analytics and data, the most popular apps in transportation are Careem, Uber, and Easy Taxi in both iOS and Android

[2] https://www.appannie.com.

platforms. To further understand the market of taxi service apps in Riyadh, a survey has been conducted and collected answers from 280 participants in the city. The goal was to validate the findings shown in Table 2 and get specific answers. The participants were recruited from social media and messaging apps. Figure 3 shows the demographics of the participants.

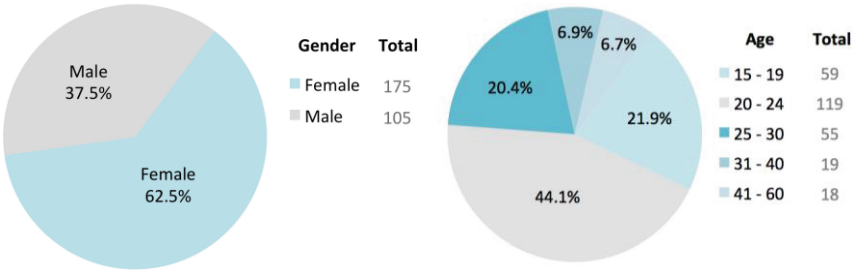

Fig. 3. The demographics of the survey participants (gender and age group)

The survey asked the participants a set of questions to understand the current transportation services and their presence in the online market. First, the participants were asked about their familiarity with a set of the most popular apps according to Table 2. The results indicate closeness in the degree of familiarity that participants had with the apps. The second questions asked the users about their usage of the same set of mobility apps shown in Fig. 4. The results indicate the popularity of some apps relative to others. For instance, when comparing Uber to Careem, it is clear how Careem is more popular in terms of usage. Also, the number of females using Uber, Careem, and Taxi London surpasses the number of males, which is opposite to the larger usage by males of the local taxi service (Aujrh) and Easy Taxi.

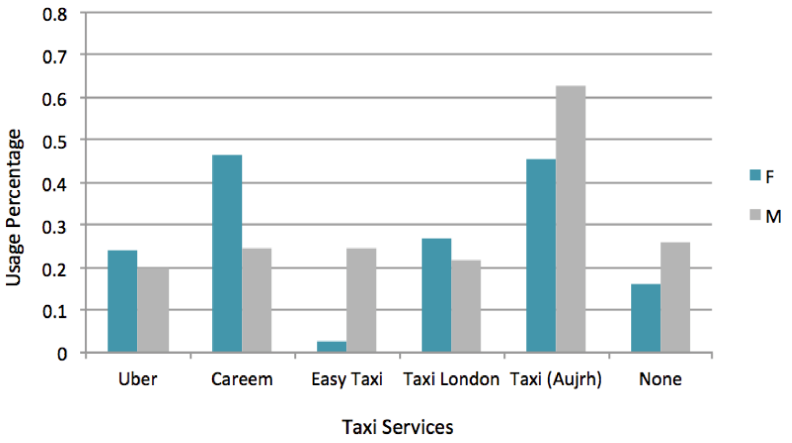

Fig. 4. Percentages of positive answers to the question: Have you used the following service?

Looking at the Twitter accounts of the most used, on-demand taxi services in Saudi Arabia, it was noticeable that the accounts are actively engaging with their customers in information dissemination, marketing, and in conversations with their followers. The data on the Twitter accounts listed in Table 2 were collected on 30/10/2015 and show the number of followers, the number following, the number of Tweets, the language used for communication, and whether or not promotions are shared. The language used most is Arabic given that the targeted audience of those Twitter accounts is in Saudi Arabia.

Table 2. Snapshot of Twitter accounts of key players in Saudi Arabia's mobility services

Account	Followers	Following	Tweets	Language
@Uber_KSA[a]	9179	712	2361	Arabic & English
@CareemKSA[b]	15400	7	4230	Arabic
@EasyTaxiSA[c]	6981	1163	2210	Arabic

3.2 Traffic Notification Systems

This section introduces some of the traffic notification systems that have been launched by government entities and self-organizing services that emerged by the community. These systems have been established to help notify commuters in Saudi Arabia in general and Riyadh in particular. The Arriyadh Development Authority (ADA)[3], the urban planning entity of the capital city, recently launched the Delilat Arriyadh app in 2014, which provides full coverage of Riyadh's road network with over 50,000 POIs, live traffic info that is updated in near real-time, and traffic flow visualizations on the map in four different colors indicating different levels of congestion (green, orange, red, and dark red indicate normal, moderate, slow, and heavy traffic). The app also displays road closures and other related road incidents. Another initiative is Hather "حاذر", an app that has been developed by AlRiyadh Municipality[4], a governmental entity, which notifies and warns Riyadh's residents from critical roads during floods and enables them to avoid these critical sites. In addition, several Twitter accounts for awareness have been introduced by some of the government entities in Saudi Arabia as shown in Table 3.

Ubiquitous technology has been playing a noticeable role in social communications in urban environments and city-wide awareness of urban issues (e.g., mobility and health outbreaks), which have been examined extensively in the design literature [18, 19]. In the context of Saudi Arabsia, several examples of urban mobility technology solutions have emerged that are aligned with citizen-science, allowing members of the community to share and help others. In terms of navigating the city and avoiding congested or blocked parts of the road network, apps have recently been introduced from community-based initiatives that provide ways for frequent users of Web apps to better understand which parts of the city road network are congested, unsafe, or

[3] http://www.ada.gov.sa/ada_e.

[4] https://www.alriyadh.gov.sa/en/news/Pages/hazer.aspx.

blocked. Table 3 shows some of the apps and Twitter accounts that have been developed by the community. Some of these accounts are to notify commuters of critical traffic issues in general (e.g., @ArRiyadh_ADA, @Amanatalriyadh, @RiyadhTraffic, and @jed_rd1 Twitter handles), and some accounts have been initiated to inform commuters to avoid blocked roads due to current metro construction (e.g., @Riyadh_Metro and @RiyadhTransport Twitter handles). Other apps and Twitter accounts are to notify border crossers between Saudi Arabia and Bahrain of the traffic status at the borders (e.g., Zahma O La and Eljisr apps, and the @Eljisir Twitter handle).

Table 3. Some of the apps and Twitter accounts initiated by the community

Apps	Twitter accounts
Government	
Delilat Arriyadh	@ArRiyadh_ADA
Hather	@Amanatalriyadh
	@RiyadhTransport
	@Riyadh_Metro
Community	
Zahma O La	@RiyadhTraffic
Eljisir	@Eljisir

[a]https://twitter.com/Uber_KSA
[b]https://twitter.com/CareemKSA
[c]https://twitter.com/EasyTaxiSA

3.3 Tapping into Social Conversations About Urban Mobility in Saudi Arabia

To acknowledge the efforts of the governments in engaging with the public in traffic issues, tapping into social networks is needed. Conversations around mobility and transportation trends continue to happen through multiple channels, including social media. This section focuses on those conversations happen on Twitter. Looking at Table 3, it can be seen that government entities responsible for planning or mobility (e.g., the ADA and Alriyadh Municipality) have a presence on Twitter and engage in conversation with their followers by sharing news and updates on new or existing projects. Figure 5 illustrates an example of the type of conversation shared by the @ArRiyadh_ADA Twitter account. In this Tweet, the ADA is sharing the Investment Climate report for Arriyadh.

Other conversations that occur on Twitter are through hashtags in which users Tweet notifications regarding traffic or other mobility issues targeted to both the public and the authorities in order to get their voices and concerns heard. The following are some Twitter hashtags in which traffic, roads, metro, construction, and other mobility issues are often discussed: #قطار_الرياض، #أين_المرور، #طرق_الرياض، #مترو_الرياض and #Riyadh_Metro.

Fig. 5. An example of the Tweets sent by government entities

The collected hashtags are all related to the mobility dynamics in Riyadh and were selected to show how citizens engage in social conversations. For example, Fig. 6 depict the network of related hashtags for the hashtag #أين_المرور though hashtagify.me.

Fig. 6. Network of hashtags related to the hashtag # أين_المرور

The network of the hashtag of # أين_المرور (translates to 'where is the traffic police' and shown in the red node) displays hashtags that are relevant to car accidents and traffic, such as speed cameras and emergency hashtag the nodes shown in grey. The other hashtag is about Riyadh roads and is showing related hashtags about traffic. The edges of the network indicate the correlation of the node connected from the hashtag of interest. The size of the node indicates the popularity of the hashtag.

4 Conclusion

Given that capturing the mobility patterns of people on transportation networks presents clear challenges; the results of this work suggest numerous avenues of possible exploration. Anecdotal evidence indicated an increasing use of social media in the Saudi population and suggested potential for tapping into social media conversations

for insight into understanding urban dynamics. Using Twitter and the other social media accounts of the three popular taxi services (Careem, Uber, and Easy Taxi) as examples, a descriptive statistics is presented to characterize and measure the potential influence of social media on the mobility dynamics in Saudi Arabia in general and in the city of Riyadh in particular. One area where this research work of establishing an in-depth understanding of social communities of urban mobility has the greatest potential is in understanding the relationship between online and offline communities in an urban context. These insights provide a step towards understanding and visualizing mobility patterns of citizens in an urban context.

Based on this exploratory study of social media communities and the Web presence of the mobility services in Saudi Arabia, our findings suggest that mobility service apps that have a strong presence in social networks (such as Careem, Uber, and Easy Taxi) are used more than other mobility services. Also, active mobility services on the Web that interact with their customers through social media seem to attract much more people. Transportation services' presence in social networks enables researchers to analyze mobility patterns and model the dynamics between social networks and mobility behavior. In contrast, few studies have been conducted on how conversations about taxi services and road issues (congestion, weather-related blockages, construction rerouting, traffic accidents, drifting, etc.) on social networks could impact the ways those services are used [16, 17].

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