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Temporary user-centred networks for transport systems

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ABSTRACT

The concept of Temporary User-Centred Networks (TUNs) for transport systems is introduced. Affinity in these networks is defined as the time-specific degree of equivalence between travel patterns of users in the system. TUNs reveal latent social structures typically invisible to their users, enabling circumstantial collaboration opportunities amongst them. To make TUNs explicit we quantify affinity as a combination of two measures: journey similarity and journey substitutability. In the urban public transport domain, TUNs enable the diffusion of knowledge across the system in real-time. This can assist passengers adjusting travel decisions to their preferences and objectives according to service status. An enriched Automated Fare Collection (AFC) system dataset is used to demonstrate the market potential of TUNs in the urban public transport domain.

1. Introduction

Developments in information and communication technologies (ICT) have paved the way for new forms of collaboration across diverse service domains (Greengard, 2011). This evolution has allowed for various kinds of underlying interpersonal affinity to materialise in actual ties between users. Personal ties such as friendships or professional relationships are tangible social structures replicated in ICT-based social networking services. Yet affinity also exists in more abstract forms, with resultant ties increasingly facilitated by the ongoing evolution in ICTs. For example, interpersonal affinity may be a shared interest or ideology revealed across a social media platform, such as a recommendation or rating system. Whatever form affinity takes, the resultant ties between users have already enabled unprecedented collaboration-based value creating processes by harnessing knowledge distributed amongst users themselves (O'Reilly, 2005). This can be viewed as a step beyond value "co-creation", in which suppliers engage customers as a co-creator of value; instead, ICT-based social network services represent a form of consumer co-creation of service value (e.g., Payne et al., 2008).

This trend has emerged across service industries, from retail (e.g., reviews on Amazon.com, ratings on eBay) to tourism (e.g., reviews on TripAdvisor.com), to health (e.g., crowd creation on CrowdMed), and to media (e.g., crowd creation on Wikipedia, film ratings on IMDb), just to name a few. The users involved, which may be consumers, service providers, or members of the public in general, create value in a variety of forms, including decision-making support with review and rating platforms, and problem-solving know-how compiled in crowd creation systems. In the transport systems domain specifically, applications already exist that leverage interpersonal affinity as the shared consumption of a particular service, aggregating reviews to assist travel choices. E-hailing applications that feature driver and passenger ratings (e.g., Uber) illustrate this well, by letting consumers and service providers each review their experiences of the other. Still, much

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potential for collaboration in transport systems remains to be explored. In particular, drawing greater value from interpersonal affinity in transport systems most likely must account for the inherent spatiotemporal dynamics.

This paper introduces and operationalizes the concept of Temporary User-Centred Networks (TUNs) in which *affinity* is defined as the time-specific degree of equivalence between travel patterns of users in a transport system. TUNs aim to identify circumstantial user-based collaboration opportunities to facilitate the diffusion of knowledge spread across a system in real-time. TUNs have the potential to produce benefits ranging from improved travel experiences to the reduction of carbon emissions. For example, urban public transport TUNs may increase the visibility of service status for passengers, permitting them to adjust travel decisions in real-time to better fit their preferences and goals. In private motorised transport TUNs could facilitate dynamic routing choices by car users based on the distribution of real-time traffic information. TUNs may also help urban cycling beginners identify experienced peers with equivalent travel patterns, to become their training buddies. TUNs may even provide an entirely new approach for the assignment and routing of Demand Responsive Transport (DRT).

TUNs materialise spatiotemporally dependent ties between users, using two *affinity* measures that are tangible and quantifiable. TUNs differ from existing ICT-based social networking services where the spatial element is typically absent or, in fewer cases, stationary (for example, to connect guests at a local attraction or event). TUNs generate opportunities to leverage knowledge that is distributed across the transport system at any time through collaboration between users. This may expand the knowledge users have of the transport system by increasing the type, availability and timeliness of information at their disposal. This will ultimately help improve travel experiences and satisfaction, of clear relevance to users, agencies, and policy makers. This paper demonstrates the concept of TUNs and evaluates their potential, based on the proposed *affinity* measures, using an urban public transport system as a case study.

2. Leveraging distributed knowledge in transport

In recent years, attempts have been made to capitalise on increasingly ubiquitous personal communication, computing and sensing devices (e.g., the smartphone) to leverage the knowledge distributed amongst transport system users. Transport agencies, for example, are ever more present in social media services (Austin, 2010; Gault et al., 2014). This facilitates engagement with citizens and enables the distribution of timely information (Bregman, 2012). Yet these social media services tend to be top-down (i.e., from supplier to user), and structured according to forms of interpersonal affinity poorly related to short-term travel patterns (Cho et al., 2011), so it becomes difficult to source and filter information and make it reach the target audiences in real-time (Nunes et al., 2011). This limitation has prompted recent studies on harvesting transport-related information from social media using text-mining techniques (Carvalho et al., 2010; Gal-Tzur et al., 2014b, 2014a) and on developing smartphone applications that spatially structure and aggregate crowdsourced data from travellers in a transport system, such as Waze, Moovit (Olson, 2014), and Tiramisu (Steinfeld et al., 2011, 2013). At best, these data-centred approaches only superficially reflect affinity between users in the transport system, thus providing limited ability to proactively filter and forward information to them based on their travel patterns.

So in spite of these efforts, user collaboration-based value creation processes have yet to fulfil their potential in passenger transport. In public transport, some evidence has emerged of companies and agencies taking a co-creation approach to service enhancement. Gebauer et al. (2010), for example, argue that the Swiss federal railway operator has relatively recently moved towards a value co-creator approach in interacting with its customers in problem-solving, co-designing, amongst other activities. In the USA, many public transport agencies, partly due to financial constraints, have also taken what one could call a value co-creation approach with users, releasing real-time data for use by third-party developers to create real-time information services for users (e.g., Brakewood et al., 2015). The relatively modest amount of co-creation activity in this realm may be partly attributable to the fact that public transport services tend to be monopoly-provided or, at least, oligopolistic (Evans, 1991). Adding to this institutional setting, the spatiotemporal nature of transport-related information makes it highly contextual and transient (Wolfson and Xu, 2010). Leveraging distributed knowledge through collaboration is therefore a challenge that remains to be addressed. For example, information about a traffic incident is only relevant to those who are geographically affected by it, and only over a short time period until it gets resolved.

Still the user-based value creation potential of distributed knowledge in a transport system has been revealed across a range of studies. The proliferation of smartphones has rapidly increased the spatial and temporal resolution, quality, speed and communicability of user-generated information on mobility systems, even in the most traditionally data-sparse settings (e.g., Zegras et al., 2015). Research on the information needs of travellers has highlighted the importance of early warnings regarding unscheduled disruptions and information about safety and comfort-related aspects associated with travel alternatives (Caulfield and O'Mahony, 2007; Chorus et al., 2006, 2007; Windmiller et al., 2014). Those types of information have the potential to raise travel satisfaction by managing travel time expectations (Li, 2003), and allow travellers to adjust travel choices according to their preferences and needs (Costa et al., 2012; Lathia et al., 2013). Whilst it may be unfeasible for transport agencies to provide such information in real-time, it can be sourced from travellers that are scattered across the transport system, who are the first to observe most events. It has also been shown that the availability of information obtained from others has potential to raise the efficiency and utility drawn from travel choices, particularly in relation to non-recurrent travel behaviours (Iryo et al., 2012).