CityVerve: Smarter Transport through data analytics

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ABSTRACT
As part of the CityVerve project, a pilot was undertaken with the objective to generate a source of data and insights that will help the city of Manchester make data-driven decisions on cycle planning and infrastructure provision that would help encourage more people to cycle. It provided a way to generate never-before-seen data from cyclists at scale across a city in near real time including road surface quality, cycle routes used, cycling blackspots and use of cycle paths.

KEYWORDS
Smart Cities, CityVerve, cycling

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1 INTRODUCTION
CityVerve (www.cityverve.org.uk) is a UK government-funded smart city project applying Internet of Things technology in the city of Manchester, UK. The project has 21 partners creating more than 20 use cases in the application areas of transport, health & social care, energy and culture. In this demonstration we will focus on a transport use case. This paper will outline how an innovative pilot deployment has engaged the cyclist community in a bottom-up approach where over 180 cyclists volunteered to share data and insights for their city so that their cycling experiences could help shape decisions about cycling infrastructure and plans. With the costs of congestion estimated at Â£1.5bn per annum, air quality issues and the health consequences of inactivity, the city of Greater Manchester has an objective to create a modal shift towards cycling, from 2% of journeys currently, to 10% of journeys taken by bike by 2025. With 30% of car journeys at under 1km distance, there is a significant potential for change if the right cycling environment can be provided.

2 CITYVERVE CYCLING PILOT
As part of CityVerve a pilot was undertaken with the objective of generating a source of data and insights that will help the city of Manchester make data-driven decisions on provision of cycle planning and infrastructure that would help encourage more people to cycle. It was also aimed at provide a compelling use case for CityVerve, by demonstrating how real-time data can be analysed and visualised in the BT CityVerve Data Hub in combination with other project data feeds (the data hub can be seen at https://portal.bt-hypercat.com).

3 DATA COLLECTION
The pilot involved 180 cyclists who volunteered to take part and who paid for a subsidised See.Sense ICON bike light. The user group was selected from more than 400 volunteers to provide a representative demographic sample. The light has a set of sensors and can collect anonymised data about bike journeys, including location and bike motion in three dimensions (that is, not only forward velocity but also tilt motion and vertical motion). See.Sense’s lights shine both in daylight and at night time; and react to moments when a cyclist may be at risk (such as at a junction or intersection) by automatically flashing more strongly and quickly. Additionally they automatically adjust brightness levels in clearer or lighter conditions, not only to conserve battery life but more importantly to keep cyclists more visible for longer. An associated mobile app also lets cyclists customise their lights and send and receive low-battery, crash and theft alerts. The sensors within the lights detect any road issues or poor road conditions that a cyclist faces. The pilot is innovative in a number of aspects. It provided a way to generate never-before-seen data from cyclists at scale across a city in near real-time. The type of data collected including road surface quality, cycle routes used, cycling blackspots and use of cycle paths are available because of the fine-grained wealth of data reported by the bike light sensors. This data was also combined with a range of other city data aggregated on the BT CityVerve Data Hub.

4 DATA PRIVACY AND PARTICIPATION
As part of the pilot design, mapping between the participants and the trackers used was not recorded. Additionally, data privacy of the participants was maintained by sharing anonymised and aggregated data only. Participants were encouraged to set geo-fenced privacy zones around areas of home or work where they did not wish data to be collected. There has been a high participation rate with over...
75% of cyclists actively collecting data, with over 4000 journeys recorded and over 25,000 kms logged and over 385 travel issues recorded. The trial results clearly showed representative data from a broad range of cyclists and was not skewed to a particular segment. This is important for planners who want to encourage more women, children and the elderly to cycle.

5 DATA ANALYTICS
Data aggregated across all participants was analysed to provide useful insight for the city with goal to inform future planning and investment. Presented here are some key examples of this data specifically road surface quality information and cyclist directionality analysis. Figure 1 summaries the road surface quality data collected within the Manchester city centre area categorised into three distinct classes: green - smooth road which is pleasant to cycle on, orange - a road that has a reasonably rough surface and is less pleasant to cycle on but sufficient for low speed commutes and red - a road considered to be very rough with significant cracks and defects or a cobblestone street. This parameter is referred to as the See Sense Roughness Index (SSRI) and has been trained using a random forest classifier applied to data manually collected by cycling over a number of different types of road surface. This classifier was then applied to the trial data and the results plotted using the leaflet package in R. This citywide view of the road surface is the first time a crowdsourced dataset has been used in this manner and allows city officials to understand where cyclists experience the roughest surfaces within the city. Action can then be taken to improve the road surface, not just for the comfort of cyclists, but for all road users. Highlighted is a particularly poor stretch of road in the west of the city centre, Lower Byrom Street, which is extremely degraded most likely due to recurring maintenance work (see Figure 2).

Another element of the data collection trial is the GPS data which is collected once per second during a cyclist’s journey. This high temporal resolution yields highly accurate information pertaining to the exact route of the cyclist as they navigate through the ever-changing urban environment. Figure 3 illustrates the directionality of the cyclists along two segments of road and can be used to assess the usage of the road by cyclists. Figure 3 is a segment along Oxford Road in Manchester which has undergone major redevelopment in order to create separated bicycle lanes. Yellow lines indicate journeys by cyclists heading north into the city centre and blue represents cyclist heading south away from the city centre. There is clear delineation between the two directions and it is clear that cyclists can use the lanes in the direction of travel without needing to manoeuvre out of the cycle lane.

Figure 4 is another segment of road less than a mile away where there are no separated cycle lanes and cyclists travelling in both directions routinely move from one side of the road to the another while traversing this area. This behaviour not only slows the cyclist down but can impact upon their comfort and safety. An average speed of 19.3 km/h for the journeys portrayed in Figure 3 and 12.7 km/h for Figure 4 illustrates this point and details how the improved cycle infrastructure enhances a cyclist’s journey.

6 NEAR REAL TIME INSIGHT
Data collected during the pilot has also been combined with other relevant data sets on the BT CityVerve Data Hub in particular with information about cycling infrastructure, cycle use, and other traffic and environmental data. This data has been pulled into near real time visualisation and analysis system to demonstrate the potential this kind of analysis can offer city planners (Figure 5).

Ability to access the data from multiple heterogeneous sources in near real time can give better visibility of how city infrastructure is being used. Figure 6 displays a view of two types of cycle counters - traditional physical ones (existing hardware on the road, in red) and virtual ones (in blue) created by the data collected from
7 CONCLUSIONS

Insights gathered in this pilot derive from the analysis and visualisation of multiple data sources and they have been crucial for engagement of stakeholders, both in the city and with cyclists. Implementation of actions based on the insights gained will be at a later stage, whereby the findings can be translated into policy and actions to implement change. It will be important for the city to provide a feed-back loop to demonstrate a response to the data and insights contributed by the cycling community in order to maintain the trust and ongoing commitment of the cycling community.