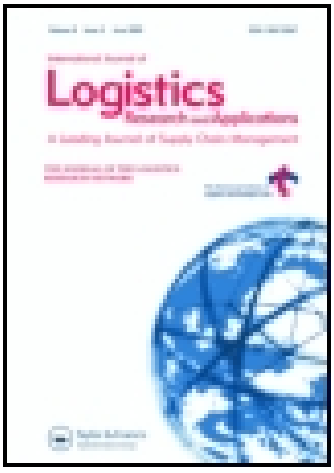

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This paper reports on the development of a smartphone app designed to give drivers and managers in a charity organisation greater visibility of transport, donation bank and shop stock in time and space. Trials of the app with samples of drivers and shop managers across three counties in the UK showed that users' understanding of vehicle activity and how time was utilised in the business was enhanced. The app also informed their decision-making, aided some collaboration and helped in their understanding of donation bank and shop performance, with one region altering their collection schedules. The quality of 3G signal was an issue in certain areas which impeded performance and the rules by which the messaging platform should be used in such a tool need careful consideration.

Keywords: smartphone apps; charity logistics; social networking

1. Introduction

The advances in ubiquitous computing have meant that our society is becoming increasingly connected, and the rapid adoption of mobile technology (Ofcom 2011) has afforded people more visibility and fluidity in their transportation decision-making (Ling 2004). Because of its ability to create user-relevant contextual awareness, smartphone app development across the travel domain has increased, with a proliferation of applications allowing users to visualise transport modes, goods and services in a space and time relevant to their current and future locations. Of real interest is the way apps are now enabling travellers to micro-manage their itineraries (Wang, Park, and Fesenmaier 2011) through the use of geo-fencing and tagging to obtain alerts to facilities, services and offers.

Smartphones coupled with social media allow people to be connected to one another continually. Through the rise of Web 2.0, users can easily generate and share photographs, video and blogs at any point in time, creating a rich information environment to improve individual decision-making. In the tourist domain, the benefits of this became evident during the 2010 volcanic ash cloud which badly disrupted air travel across Europe and led to Facebook and Twitter

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becoming important news wires, relaying travellers' experiences and recommendations. Social networking principles not only apply to transport users but their individual vehicles, the public transport they utilise and the objects with which they come into contact through what is termed 'the Internet of things'. This creates new opportunities for shared use of resources, collaboration and sustainable travel with the smartphone being the key information management device.

While the benefits of smartphones in the tourism domain have been documented (Dickinson et al. 2012), their scope for enhancing visibility of activities and opportunities within logistics companies and between customers, logistics providers, shippers and couriers is now starting to be explored. Commercial fleet management systems using rugged hand-held terminals have been in existence for a number of years, and act as the core communication platform in many large carrier operations. Smartphones and tablets now mirror the functionality of these devices and are becoming a viable alternative as data collection and dissemination devices in the logistics field. This paper reports on the development and testing of a smartphone app, designed to combine social networking concepts with asset tracking and monitoring to enhance the visibility of logistics operations within a national UK charity, Oxfam. The paper starts with a review of smartphone characteristics and their potential use in logistics. The research challenge is then introduced in Section 3 with reference to the Oxfam case study before the app platform and functionality are described in Section 4 with the key findings from the trials in Section 5.

2. Literature review

A review of the literature set out to identify the current take-up of smartphones in society, their use for aiding travel decision-making and their specific qualities relevant to aiding operations in the logistics sector. Current research suggests that there will be 30.9 million smartphone users in the UK by the end of 2013 (Anon 2013a), equating to 48.4% of UK residents and 60.4% of UK mobile phone users. By the end of 2014, two out of three mobile phone users and 53.7% of the UK population are anticipated to be using smartphones which will rise to 43.4 million users (81% of mobile phones) by 2017 (Anon 2013a). Through the use of Web 2.0, smartphone apps are now enabling the upload of photos, blogs and user recommendations to a variety of social media sites whilst users are on the move (Buhalis and Law 2008). They have proved very effective in the tourism domain where travel plans have been altered based on user-generated content and travel updates posted via smartphones to social networking sites (e.g. during the 2010 volcanic ash cloud crisis which struck Europe, Dickinson et al. 2012). The ability to reveal a user's location has led to apps such as Avego (http://www.avego.com), which allows people who require a lift to visualise car owners' real-time location and their routes so that they can meet up and avail a lift. The potential for apps is enhanced still further as 'near-field' technologies emerge, allowing users to exchange data with objects and for objects to exchange information with each other as part of an 'Internet-of-things'. Smartphone use is starting to soften the traditionally close connection between activity, place and time, affording users a more spontaneous negotiation of meetings and transactions within their daily activity (Wang, Park, and Fesenmaier 2011). Because of their ability to allow connection with everyone in a community all the time, as a socio-technical device, they greatly enhance how users engage with place and time (Wilken 2008) and impact on the spatial and temporal organisation of our activity scheduling and wider social interactions (Campbell and Kwak 2011; Line, Jain, and Lyons 2011; Neutens, Schwanen, and Witloz 2011). In a personal sense, the smartphone is now enabling more negotiated scheduling of activities to better cater for our dynamic needs and circumstances. Of interest in the context of this paper is to what extent these devices will alter logistics patterns (particularly 'last-mile' delivery) which are traditionally rooted in clock-time (e.g. having fixed delivery time windows). Customers, through

their own handsets will be able to liaise with carriers to arrange and renegotiate meeting places to potentially better suit both parties and avoid failed deliveries. Our extempore lifestyles which see a much more fluid and spontaneous approach to arranging meeting places (Kwan 2007, 437) could be catered for in a logistics scheduling context due to the ever-increasing power of vehicle routing and scheduling software.

Commercial-grade smartphones are now being used in the logistics sector where previously only ruggedised devices would have been considered able to survive the often harsh environment (Roach Partridge 2011). Their functionality in terms of battery life, data storage for batch functionality, data entry via keyboard, barcode scanning or voice recognition and a good quality camera for stills or video capture means they now rival the bespoken devices traditionally used in this sector. Their lower entry price coupled with their widespread use and user acceptance make smartphones and tablets an attractive platform. TomTom's Webfleet management system is available across Apple's iOS operating system and the Android platform and allows managers to locate vehicles and interact with them via their phone (Anon 2012). This has seen an increase in BYOD ('Bring Your Own Device') in the logistics work place (Anon 2013b), where employees use their own personal devices to access their company's databases and systems using specific apps. This can have significant benefits, not only in cost reductions but in ease of access for the employee (who previously may have had to carry several devices for personal and business use) and to encourage greater engagement in activities.

3. Description of the problem and research challenge

Oxfam has a network of around 650 high street stores and approximately 1300 donation banks across the UK generating books and textiles. The charity operates a complex reverse logistics process across several separate vehicle fleets, servicing these stores and banks. This enables Oxfam to transport goods, primarily second-hand books and textiles, from banks to stores or processing centres, and to move goods between its stores for resale. The logistics operation involves a centralised vehicle fleet serving the large sections of the network and localised 'man-with-van' operations, targeting specific banks and shops. The former feeds recyclate generated by the stores back into recognised commercial recycling streams and provides the take-back of low-grade clothing to a central sorting facility for separation and onward processing. The latter is very region specific, where paid and sometimes volunteer drivers will service certain shops and banks, whilst also undertaking ad hoc work such as commercial and house collections. The different transport layers work largely in isolation and there is scope to use information communication technologies to enhance their visibility. With such a complex, multi-actor supply chain structure, the research challenge lies in:

(1) Developing a simplistic data collection, mining and dissemination tool that can be utilised by all the players involved.
(2) Designing it in such a way that it provides enhanced visibility of network performance in time and space, improves temporal decision-making and fosters greater collaboration between the players without compromising data protection and privacy obligations.

The research focussed on using smartphone technology to develop such a tool, given its ability to accurately track users whilst, at the same time, providing a platform to allow data entry, interpretation and visualisation, and potentially for staff to utilise on their own personal phones at work.

As part of the 6th Sense Transport project (www.sixthsensetransport.com), a series of interviews and an expert working group of Oxfam area shop and transport managers were convened to discuss what issues currently hindered logistics efficiency and greater collaboration between

the players, and how such a tool could be designed to help mitigate this. Area managers felt that they needed more timely information on the performance of the man-with-van local logistics, particularly with respect to the actual servicing needs of donation banks and shops in the area. More timely reporting of bank fill levels was sought, particularly if they could be visualised remotely, enabling managers and drivers to better plan collection schedules and be more 'reactive' to the fluent needs of the business. Ways in which communication could be enhanced between the members of the community were sought, particularly where opportunities for greater collaboration presented themselves through the provision of more dynamic and current information. The personal smartphone provides an easily accessible platform by which all the parties in the network can engage and participate.

4. Platform design and functionality

Following on from the focus group, a series of wire frames and story boards were produced and through an iterative design-consult process, the core functionality was developed. The app itself was written in iOS for the Apple iPhone platform which was the base tool used across the apps being developed as part of the 6th Sense Transport project. As Oxfam operates across separate regions, each having an area manager overseeing a series of shops, which may or may not use an area van driver and sometimes volunteer drivers, the app functionality was built around the concept of a community in which all the players (area manager, shop managers, paid and volunteer drivers) post, share and view information about operations in real time.

4.1. *Representing assets in the Oxfam network*

The four main assets represented are donation banks (either textile or book banks), Oxfam shops (either clothing or book shops), other outlets (e.g. commercial collections from companies and occasional house clearances) and drivers (either paid or volunteer). The app uses a database of fixed asset locations (the latitude and longitude of each donation bank and shop), grouped by Oxfam region, and represents these on the map as a series of interactive pins, through which the transactions and messages are accessed by users (Figure 1(a)). Each shop and bank acts as a unique bulletin board, allowing users (both drivers and managers) to post/read messages to/from them and access the history of collections/deliveries associated with them in time. Drivers appear in the network as dynamic pins, moving around as their journey progresses and have a similar functionality to the banks and shops in that system users can post messages on them and view the transaction activity being undertaken by them as it happens.

Ad hoc commercial collections of textiles from businesses and house clearances, pre-booked by members of the public, are also significant revenue-generating opportunities for Oxfam. These sites are created by the driver in the app as they are undertaken and help provide a record of unique transaction activity in time and space across the region.

4.2. *The app as a data collection, stock notification and driver tracking device*

The app was designed to have two levels of functionality for two separate user groups: managers and drivers. Drivers act as the core information gatherers in the system, recording for each bank collection (Figure 1(b)):

(1) The percentage fill level of the bank on arrival.
(2) The number of bags of stock generated (the driver typically empties the contents of the bank and places it into 60 L hessian sacks to a maximum sack weight of 7.5 kg).

Figure 1. 6ST Oxfam app showing (a) the main screen view of shops (S) and banks (B) and drivers (D) in the network. Each asset pin is interactive when touched (the Sainsbury's March donation bank is displayed with the fill level, determined by a remote sensor, as of 5 June 2013) (b) the donation bank stock collection screen (c) the shop delivery screen (d) a push message notification being received from a book bank at a supermarket site.

(3) The stock quality of the bank (a gauge of the general stock quality on a scale of 1 (poor) to 5 (excellent).
(4) The percentage fill level of the bank at the end of the collection (which might not be zero if there is stock damage or a capacity issue on the van.
(5) Any comments about the collection (this includes text comments and photographs).

At each shop, drivers record the numbers of bags transferred as either a delivery of good stock for sale (Figure 1(c)), sourced from either a bank or another shop, or a collection for 'cascade' to another shop (where the shop concerned has stock, which for a variety of possible reasons has not been sold but could potentially be sold at another location). At the site of a commercial collection or a house clearance, the driver 'adds' a new site into the network at that specific geo-location, declaring its name and category, and recording the number of bags/boxes collected by product type along with any comments. To conserve battery life, the app does not continuously track the driver's progress as in a traditional satellite navigation system. Instead, the driver's latitude–longitude location is refreshed whenever the phone is activated in any way, or the driver passes between cell stations of the phone's network provider.

Each time a stock collection is made from a donation bank or from a shop in the form of a cascade, the other members of the community are notified via a push notification from the app to their iPhone or iPad giving the site origin and message 'stock collected available for cascade' (Figure 1(d)). Push notifications alert the community of all transactions and messages as they are entered into the system by the respective user. These act as a temporal reference point for all members of the community, with managers able to view a driver's current position, and then visualise where he or she should be, at hourly intervals, during the rest of that day, using a continuously updating geo-location history logged by the system. This feature was designed to allow managers to understand the driver's likely movements, which could be useful, for example, when considering how to respond to incoming house/commercial clearance requests. The 'heat map' produced (Figure 2(a)) is a visualisation of the intensity of driver transaction activity (latitude and longitude points where transactions were logged in time) with areas of higher intensity (greater number of visits over time) coloured red, moving through green to blue, indicating lower intensity visitation. With each day's trip, more location histories are added to the heat map so that patterns of activity by hour and day can be understood.

A key feature of the app is the messaging system which allows the members of the community and assets within it to message each other with requests and notifications. The messaging

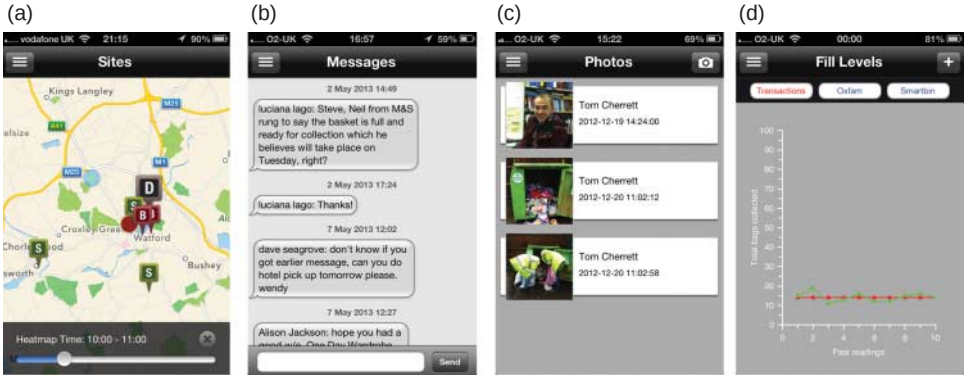

Figure 2. 6ST Oxfam app showing (a) the driver location heat map (areas of higher intensity are coloured red, moving through green to blue, indicating lower intensity visitation) (b) an example of a driver information bulletin board showing messages posted to the driver from shops (c) photographs linked to a specific donation bank site (d) donation bank collection history.

platform works on the principle that members of the community represent a specific location or asset and these entities act as the bulletin boards to which messages are attached (Figure 2(b)). In the case of shops, each manager is registered under their shop and messages are posted to that location in the network. This approach was taken rather than using named individuals because the personnel running the shop and potentially using the app vary from day-to-day and having a general shop bulletin board was considered more flexible. Drivers moving around in the network have messages attached to their map icon by users. Drivers also have the ability to take and post photographs at each bank/shop site which are then added to the message and transaction history of that location (Figure 2(c)).

As well as being able to view the contents of the driver's van, in terms of the stock held at any point in time, and the transactions as they occur at banks, shops and other locations, managers can also view the collection/delivery history of each asset in the system. For donation banks equipped with remote monitoring sensors, this allows managers to receive percentage fill readings twice per day and utilise the information to make better collection scheduling decisions (McLeod et al. 2013). Figure 1(a) shows that the Sainsbury's clothing donation bank in March was only 28% full on the morning of 5 June 2013 and did not warrant a collection due to the bank being under 50% full. The app allows this information to be shared by the members of the community where, in the case of 'shop adopted banks', the shop manager can make a better informed decision as to whether a volunteer needs to visit a bank to prevent it from overflowing.

5. Case study application with Oxfam

As part of an ongoing evaluation process, the app was trialled across three different Oxfam communities of users, over three separate counties in the UK:

(1) A driver, area manager and three shop managers in Hertfordshire.
(2) A driver, area manager and depot manager in Dorset.
(3) Two drivers, an area manager and six shop managers in Cambridgeshire.

The three communities were chosen after a consultation exercise with Oxfam during which a general call for participant regions was placed and a number of area managers came forward expressing interest. The three communities were chosen as they covered the full range of Oxfam activities in terms of stock cascading between shops, textile and book bank servicing, house

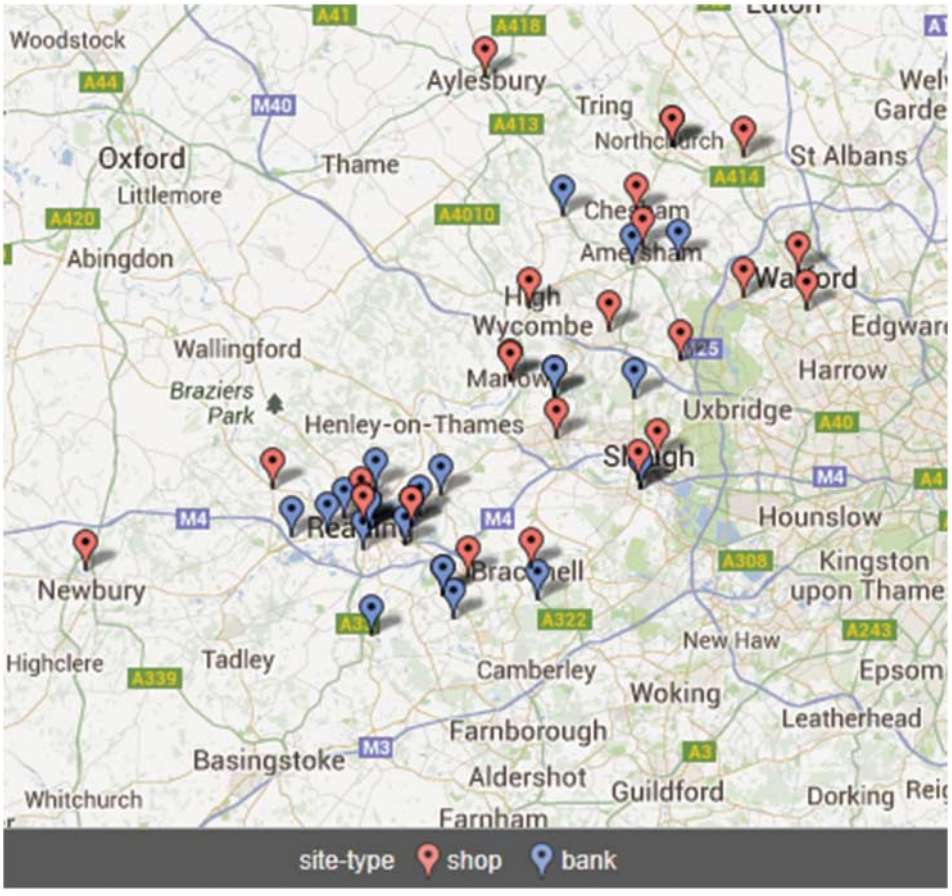

Figure 3. Oxfam shops and banks in the Hertfordshire trial.

clearance and commercial collections. They also involved the full spectrum of staff in terms of paid full-time and voluntary part-time workers, some of which were fully smartphone enabled, with others who had never experienced the technology before.

Each trial ran over a period of three months with the aim of gauging to what extent the app provided greater visibility of stock and asset utilisation, and whether this information was used by the participants to enhance existing relationships or build new relationships with other shops and banks in terms of stock management.

5.1. *Understanding donation bank performance*

Data from the Hertfordshire trial were used to understand how the information gathered by the app could be used to quantify donation bank performance and highlight sites that were underperforming relative to their neighbours. The service area involved 26 shops and 20 banks (Figure 3), monitored between 21 March 2013and 14 June 2013. During this time, a total of 1778 bags (60 L hessian sacks) were collected and logged via the app, with an average observed fill level across the 102 collections of 59% (Table 1).

Of interest are the percentage fill levels recorded by the driver on opening the bank, married to the actual number of bags collected. The results suggested that a number of banks were not performing well with a mean fill level under 45% and a yield of fewer than 10 bags per visit (the

Table 1. Donation bank performance in the Hertfordshire trial 21 March 2013–14 June 2013

Bank location	Collection (#bags)	Average fill (%)	#bags/fill level	Transactions	Bags per transaction	Dwell time (min)
E-0447-A Taplow	51	92.5	0.55	2	25.5	45.3[a,b]
E-1992-D Winnersh	121	87.6	1.38	7	17.3	19[a,b]
E-0618-D Missenden	118	80.3	1.47	6	19.7	16.5[a,b]
E-0603-D Reading	102	80	1.28	6	17	22[a,b]
E-0039-D Reading	135	75.3	1.79	3	45	47.3[b]
E-1890-D Polehampton	46	72	0.64	3	15.3	17.8[a,b]
E-0035-D Palmer Park	62	70	0.89	5	12.4	15[a,b]
E-2026-D Bagshot	245	66.4	3.69	7	35	48.6[b]
E-0039-M Reading	180	60.3	2.98	5	36	47.3[a,b]
E-2000-D Wokingham	178	60	2.97	6	29.7	31.4[a,b]
E-2519-D Milestone	55	58.3	0.94	5	11	23.4[a,b]
E-2533-D Reading	130	55	2.36	9	14.4	23.4[a,b]
E-0614-D Sycamore	24	50	0.48	1	24	17[a,b]
E-0607-D Datchet	82	45	1.82	3	27.3	23.9[a,b]
E-1834-D Tilehurst	45	41.9	1.07	6	7.5	12[a,b]
E-0448-D Farnham	95	36	2.64	10	9.5	15.5[a,b]
E-1898-D Kingfisher	30	35.3	0.85	5	6	9.8[a,b]
E-0607-A Datchet	55	29.4	1.87	6	9.2	23.9[a,b]
E-0617-D Snells Wood	24	18.3	1.31	7	3.4	10.8[a]
Average	93.6	58.6	1.63	5.4	19.2	19.2
Median	82	60	1.38	6	17	17.0
Total	1778			102		

Note: Average dwell times sharing the same letter (column 7) are not significantly different ($p = 0.05$) using Scheffe's multiple range test).

Tilehurst, Kingfisher and Snells Wood banks yielding only 45, 30 and 25 bags, respectively, in 100 days). The '#bags/fill level' statistic reflects the mean fill level of the sacks by the driver, but also hints at the different range and quality of donations received, particularly with book banks which can receive a variety of different products from books and magazines to videos, DVDs and record collections, as different items would normally be bagged separately. As the data emanate from the same driver, one might not expect the figure to vary between the sites, unless the bags have to be carried some distance, where they may be filled less. This statistic ranged from 0.48 to 3.69, with an average value of 1.63 bags per one percent fill level.

Prior to the introduction of the app, fill records were not taken and bag transactions were only submitted in paper format by the driver once per month. The instant feedback provided to the community by the app enabled the area and shop managers to better evaluate site performance and make changes (e.g. round order, site visit frequency or longer-term bank placement strategy).

> It gives me the factual proof I can take to my manager and say in comparison you can see that other banks are performing much better and they are the ones we need to focus on really, not the ones that are only doing a few bags a week. (shop manager)

> I can say to the driver, hey look at that bank, we really need to get there, because we know the quality is quite good, and looking at the pattern over the weeks, you can see the fill level is higher than others. It is kind of like a sense check. (area manager)

In the Hertfordshire trial, the van (a long wheel base transit) was equipped with a tracking device which allowed dwell times at sites to also be determined (Figure 4). The tracking data when matched with the activity log in the app gave an indication of vehicle round efficiency for each day of the week (round time per weight lifted) which suggested that Tuesdays were the least efficient (32 s/kg, 165 bags lifted on average) and Wednesdays the most efficient (17 s/kg, 252 bags lifted on average). The latter was identified as a 'shop servicing' day where bank stock collected during the first half of the week was distributed to shops and unsold stock cascaded to other outlets for resale. In terms of the mean observed dwell time, there were significant differences

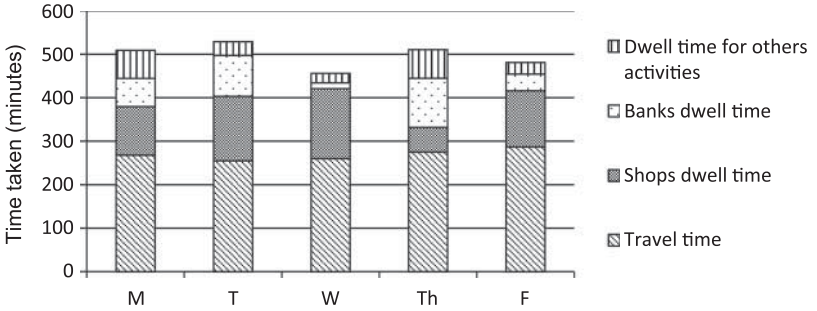

Figure 4. Time taken (min) by day of week (Profleet, 21 March–16 May).

between sites ($F_{(16,96)} = 5.38$, $p < 0.001$, $Ms_e = 15{,}043$) with the average bank taking 19 mins to service, supermarket sites generally yielding more donations and taking more service time. The data emanating from the app were used by the area manager to reassess the order of the vehicle rounds and the frequency of some bank collections.

5.2. *Collaboration and communication emanating from the app*

Of interest is to what extent such a tool can help shop and area managers visualise the timely movement of stock around the network in order to make better decisions on end-sale points and driver priority transactions. In a fluid environment where the relationships with the drivers (both paid and volunteer) are very open, this can lead to a highly reactive transport response to issues as they arise but can also lead to inefficiencies and split loyalties, with drivers becoming key decision-makers in the stock management process between different shops and other third parties (commercial and private donators, storage facilities and recycling outlets). In this sense, the drivers act as 'boundary spanners', and 'relationship champions', interacting with many different parties both within and outside the business, developing new and maintaining existing relationships (Fugate, Thomas, and Golicic 2012; Haozhe, Daugherty, and Landry 2009).

Although shops have specific sales targets and, in effect, are competitors when situated in the same catchment area, the charity very much promotes the philosophy of 'area collaboration' and the targeting of stock to shops where it can command the greatest price for the benefit of the organisation. This is necessary as shops differ in character depending on their catchment and can be roughly characterised into 'givers' and 'receivers'. The former are situated in areas which generate sufficient good quality donations through the door or via local book/textile donation banks which they adopt. The latter are more reliant on quality stock being brought in from other areas as their through-the-door donations are limited or of low value. As a result, relationships build up between 'givers' and 'receivers' where culled stock generated by the former (items that have not been sold within a given time period but are considered to be saleable) are 'cascaded' to the latter who will attempt to sell them.

The Cambridgeshire case study provided an opportunity to study how the social networking side of the app functionality was used between the seven shop managers, area manager and two drivers (one paid and one volunteer). The shops concerned were situated in Cambridge, Newmarket, Bury St. Edmunds, Woodbridge and Felixstowe. Between 3 June 2013 and 3 September 2013, 407 messages were sent between the members of the community covering stock requests (11%), offers of stock from shops ('cascade') (8%), information on stock collected and available for cascade by the driver (21%), general information and queries (19%), social chat (15%). A further 20% of messages were confirmations that a previous message had been read and understood with 6% relating to operating the app.

Table 2. Messages exchanged by category between 3 June 2013 and 3 September 2013 by the Cambridgeshire trial participants (seven shop managers, area manager and two drivers).

Message category	*n*	%	Mean time messages were exchanged	Variance
Collection	87	22.8	11:14	0.0132
Cascade	29	7.6	14:20	0.0470
Confirmation	82	21.5	14:22	0.0420
Enquiry	30	7.9	13:07	0.0507
Info	48	12.6	14:58	0.0519
Request	44	11.5	14:21	0.0440
Chat	61	16	12:07	0.0484

Note: 26 of the 407 messages were regarding operation of the app exchanged between the members of the community and the developers, not listed here.

Of interest was the time when information was exchanged between the members of the community via the app with 25% of messages being sent after 5:00 p.m. and 19% after 7:00 p.m. In terms of the times when messages were sent, there were significant differences observed between the categories ($F_{(6,374)} = 5.68$, $p < 0.001$, $M\mathrm{s_e} = 0.038$) with conversations regarding the collection of stock occurring in the morning (before midday) and enquiries and information largely being shared in the mid- to late afternoon (Table 2). Although the app proved to be a good medium for communication via the messaging platform, it did not replace the traditional methods.

Previous research (Lee, Cheung, and Chen 2007) has suggested that job-related mobile communication is associated with more complex tasks compared to mobile communication for private purposes and that the former often involves carrying large quantities of partly subtle information which a mobile phone text message is less equipped to convey, being a more informal communication channel.

The data suggested that it could be an instrumental tool for initiating transactions but that it would very much operate as a 'complementary' medium alongside telephone, email and other social media, as 43% of the 190 collection, cascade, enquiry and request messages had no confirmation messages associated with them. Evidence from the in- and post-trial interviews suggested that managers would regularly follow up message postings with phone calls.

A series of semi-structured interviews using questions scored via a five-point Likert scale ('strongly agree' – 5; 'agree' – 4′; 'uncertain' – 3; 'disagree' – 2; 'strongly disagree' – 1) were undertaken with the Cambridgeshire shop managers before, during and after the trial to gauge opinion on usability and understand how the app had aided communication and collaboration.

Five out of the six managers who participated in the post-trial interviews agreed that the app had improved communications with, and maintained the relationships between shops they already collaborated with ($\mu = 3.7$). In terms of engaging in more collaboration with shops over the trial period using the app, four out of six managers agreed that they had ($\mu = 3.3$) and a similar number felt that their relationships had improved as a result ($\mu = 3.3$) and they had developed new relationships with other shop managers in terms of stock collaboration ($\mu = 3.3$). During the trial, it became evident that the rules by which collaboration takes place and the communication protocols that enable it need to be addressed. There were instances where chat between managers, visible to others in the community, was considered 'irritating' by others and could potentially devalue the tool, with users inclined to disengage if the notification messages were considered largely 'trivial'. Also, several managers felt that collaboration could be enhanced

if there was a feedback mechanism which allowed 'giving' (cascading) shops to receive information on how much the transferred stock had sold for, thus enhancing their personal feeling of well-being and the community spirit. The opposite opinion was also expressed in that shops may be inclined to stop collaborating if they found out that certain stock they had cascaded subsequently sold well at other shops.

All of the managers agreed that they could get across what they needed to say using the short message system in the app ($\mu = 4$) but it was not universally preferred to discussing issues on the phone ($\mu = 3.2$) despite all agreeing that it saved time over calls to other shops ($\mu = 4.0$). Quotes received included: 'The instant side of the messaging to the community is really great. It's so much better than email when you have to log in and someone's got to think about it'; 'It is much easier just to send a quick message and get a response than to have to have a long-winded phone call or email that might even not be picked up for 3 days'. One of the drivers remarked, 'but I need to talk to you like in the old days when phones [texting] didn't exist', suggesting that in certain circumstances, related to specific tasks, personal one-to-one discussions were favoured over text communication.

Despite the fact that 19% of the messages were sent after 7:00 p.m., there was a mixed response to whether managers were happy to communicate out of normal working hours. Four out of the six managers either agreed or strongly agreed that they were happy to message others about work-related issues out of hours ($\mu = 3.5$), as otherwise they might forget to do so and they did not expect a response out of working hours, with two disagreeing. In terms of whether they were happy to receive messages out of hours, five managers agreed with one disagreeing ($\mu = 3.7$). In response to the question, 'messaging out of hours is more convenient than during the day', the managers were in mild agreement overall ($\mu = 3.3$), with three agreeing, two neutral and one disagreeing.

5.3. *Design, operating issues and limitations encountered during the trials*

The lack of a 3G signal in some parts of all three trial areas (e.g. Blandford Forum, Barton-on-Sea, Bury St. Edmunds and Berkhamsted) meant that sending and receiving data were problematic at times, particularly impacting on the drivers who would occasionally have to note down quantities collected and times for later entry, post event and once the signal had returned. In subsequent build iterations, it is planned to cache more data onto the phone but this requires a more complex rules base. At present, the app works in live mode where data entered are pushed out to the community in real time. If 3G or a wireless network is not available, the transaction cannot be recorded. Allowing data to be initially stored on the phone for subsequent upload is of obvious benefit to the driver but the time when the signal is regained relative to the nature of the information being sent would need to be considered in more detail to ensure that messages, once received, had not been superseded by subsequent events. As an indication of the extent of the problem more generally, Ofcom (2013) recently estimated that 3G signal coverage on A and B roads was 91% (served by at least one 3G network) and 65% (served by all four 3G networks).

'Read receipts' were considered a worthwhile addition to the functionality to enable the sender of a message to know whether it had been read by the recipient. The messaging system was designed to allow information to be associated with places and 'things' rather than individual people. In an environment where one shop might have up to 70 different registered volunteers at one time, tagging messages to the shop rather than addressing them to a specific person was considered the most appropriate approach where the app might be used by multiple users from the same site. In the spirit of creating an open community to encourage collaboration and relationship building, the app allowed all users to view the messages and activity logged at each site (be it a bank, shop or driver's vehicle). This did create some confusion when users posted messages to sites in response to a message left by another on that site, intending it to go to the originator at

their shop. Subsequent releases will look to create further sub-groups of users to allow direct and private messaging between individuals.

Aside from these issues, users on the whole found the app very easy to use in terms of logging on to the app ($\mu = 4.4$), sending messages ($\mu = 4.4$), viewing messages ($\mu = 4.5$), viewing other shops and banks ($\mu = 4.6$), navigating around on the map ($\mu = 4.5$) and finding and viewing the driver's icon (question asked of managers only) ($\mu = 4.8$) where the mean scores shown were based on interviews of the eight users in Dorset and Hertfordshire.

Apart from the practical difficulties encountered, some of the wider lessons for future research involve how to engage business communities in the initial role out of such a technology and devising the rules by which the tool should be used. Enabling more spontaneous reaction to events (Wang, Park, and Fesenmaier 2011) can be beneficial from a business perspective but can lead to inefficiency in the logistics if the related work activity is not planned. There is also the issue of how a social network develops over time using such a tool, the demarcation between business and social use and the extent to which cliques of users develop which maybe undesirable.

6. Conclusions

This paper reports on the development of a smartphone app designed to give drivers and managers in a charity organisation greater visibility of transport, donation bank and shop stock in time and space. Trials across Dorset, Hertfordshire and Cambridgeshire have shown that a personal smartphone can be used as a reliable tool to track assets and disseminate relevant information to community members in a charity retail setting, providing that the 3G network is available across the network. The ways in which the community uses the information to improve their performance very much depends on the existing relationships (shop to shop interactions, shop to driver, area manager to all) within a fluid business environment that is driven by dynamic donation patterns.

Using a five-point Likert scale ('strongly agree' – 5; 'agree' – 4; 'uncertain' – 3; 'disagree' – 2; 'strongly disagree' – 1), the shop managers in the Cambridgeshire trial all agreed that the app did provide them with extra visibility of the driver's activity over what they had before ($\mu = 4.5$) and their understanding of the driver's daily activities had improved as a result ($\mu = 3.7$). Views on whether the app had improved communications with the driver were neutral ($\mu = 3.2$) but the visibility of his current location and projected location into the future were considered useful by all: 'The visibility of where he [the driver] is and where he is likely to be is very helpful in planning activity. We are using real information instead of thinking – he might be, he might be'.

Decision-making was better informed with the data presented through the app ($\mu = 3.7$) along with enhanced understanding of donation bank performance ($\mu = 4$) and shop delivery/cascade patterns ($\mu = 3.5$). In terms of understanding how time is used in the business, five out of the six managers felt that the app had had a positive affect ($\mu = 3.8$).

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