# It's Time There Was an App for That Too:
## A Usability Study of Mobile Timebanking

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## ABSTRACT

*Timebanking refers to community-based volunteering in which participants provide and receive services in exchange for time credits. Although timebanking takes advantage of web technologies, the lack of flexibility in managing web-based timebanking transactions and the difficulty of attracting younger adults whose contributions would be highly valuable to the community still remain as major challenges. The authors' design research attempts to address these issues by leveraging the unique affordances of smartphones and their attractiveness to young adults. In this paper, the authors introduce a timebanking smartphone application and present a 5-week user study with 32 young adults. The results highlight the potential of timebanking for young population with an application that facilitates access to communications and transaction-management activities, and strengthens social connection and the sense of community attachment. The authors in particular present new affordances of smartphone technology on timebanking, including (1) transaction time reduction, (2) location and time-sensitive timebanking activity support, and (3) real-time coordination. The authors discuss design challenges and opportunities of smartphone-based timebanking.*

*Keywords:* *Case Study, Design Research, Mobile Local Community, Mobile Timebank, Social Connections and Interactions*

## INTRODUCTION

Timebanking formalizes community-based volunteering by tracking service transactions amongst community members in terms of the time taken to perform the services (Cahn, 2000). Members can "earn" time by providing a service and "spend" it by receiving a service. Unlike conventional monetary systems, time created from any type of work has equal value. Timebanking does not require reciprocal service exchanges, but members can give and receive services in a flexible way. For example, a person who has a vehicle can give a senior

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citizen a ride to and from the hospital and be compensated with time credits. The earned time credits can then be used to ask a different timebank member to fix his/her computer. At its core, timebanking encourages people to use their own unique and valuable skills to help others. This helps timebank members develop a sense of self-efficacy and achievement, regardless of their professional or income level (Cahn, 2000; Collom, Lasker, & Kyriacou, 2012; Lasker et al. 2011).

Any community interested in timebanking can run a timebank. Mostly, a timebank is formed by motivated individuals for their local community who see the value of timebanking. Each timebank has administrators and coordinators who manage members and timebanking activities. At this stage, a local timebank adopts one of the existing technology software platforms designed to facilitate managing and operating a timebank more efficient ways. There have already existed a few large timebank organizations providing web-based software platforms to simplify what was traditionally paper-based work by coordinators. *TimeBanks USA* (http://timebanks.org/), one of the largest timebank organizations consisting of about 250 local timebanks with over 25,000 members in North America and 13 other countries, created a web-based platform called Community Weaver. *hOurworld* (http://hOurworld.org/), another national non-profit organization that has over 190 local timebanks with over 20,000 members (as of June 2014), also provides a web-based platform called Time and Talents. Such timebanking platforms facilitate more efficient timebanking interactions for members as well as reducing the work for coordinators. For instance, members can easily set up their accounts, provide and access a list of requests and offers, and record time credits. For coordinators, they can easily manage overall members' activities and time credits.

In this paper, we are interested in tackling two major challenges in particular. The first is the lack of flexibility in managing web-based timebanking transactions for members, mainly because they are not always connected to the webpage of their timebank when they are in need of services, in the position to offer help, or in the stage of reporting time credits. This could lead to underreporting of timebanking transactions, which in turn lowers the visibility of timebanking contributions to the public good, giving rise to underestimates of the utilization of timebanking. Good estimates of utilization and benefits are needed when seeking funding for timebanks; thus, reporting those transactions is important. The second challenge is that timebank members are disproportionately single, Caucasian, and highly educated elderly females (Collom et al. 2012). Because of this, the types of timebanking services available are limited to some extent. This lack of a fully diverse population and lack of a broad range of services both reduce the attractiveness and viability of timebanks. For these reasons, timebanks consider a diverse membership as a key to their survival.

Considering a number of positive influences that have been created and supported from technology to timebanks, we believe that leveraging newer technology would provide better solutions that have not been well addressed in web technology. Many timebanks that we have contacted (e.g., hOurworld, TimeBankUSA, CommunityForge, etc.) want to leverage opportunities from new technologies yet still confront a number of challenges such as limited personnel resources and a shortage of funding (Collom et al. 2012; Molnar, 2011). In this regard, we proposed to bring timebanking to the smartphone platform because smartphones have become widely adopted by people.

We introduce the design and implementation of a timebanking smartphone application in collaboration with one of largest timebank organizations, hOurworld. Since a timebank's success depends on the participation of a diverse set of members, timebanks are especially interested in growing their members by engaging the young adult population. We conducted a five-week user study involving 32 young university students. From the study, we investigate their adoption and early use of the application on the hypothesis that supporting

timebanking activities with a more personal device might fit students very well because the ownership of smartphones is particularly high (nearly 80%) among that population (Smith, 2013), and, with their energy and diverse skills, they would be an ideal population to attract to timebanking, diversifying the population and leading the way for other young adults. Our study summarizes the overall usage of the timebanking smartphone application by students and highlights some distinctive affordances of smartphones for timebanking. To measure the aspects of mobile technology, we specifically present its affordances on timebanking in three directions: (1) transaction time reduction, (2) location and time-sensitive timebanking activity support, and (3) real-time coordination. We further consider if timebanks with a smartphone platform and a new user group could be part of the whole vision of timebanking by articulating participants' social connections and their sense of community attachment.

The following are the contributions of this study. First, we present timebanking activities created and shared among a young population through the timebanking smartphone application, which has not been reported on in previous timebanking literature. Second, we discuss new affordances of the timebanking smartphone application, which will broaden the range of timebanking task-related services, activities, and interactions. Third, we articulate some fundamental aspects of timebanking, including social connection and sense of community attachment, and some challenges encountered during the study for application design improvement.

## RELATED WORK

### Motivations, Opportunities, and Challenges of Timebanking

A number of existing virtual currencies are operated and maintained by utilizing technologies to allow their users to easily manage a personal account and engage in economic transactions. "Bristol Pounds" is an example, taking the form of a city-wide electronic local currency. Local people exchange their money for Bristol Pounds and use them with participating businesses via various methods (paper, web, or mobile) of payments. Another example is "Bitcoin," a peer-to-peer electronic virtual currency system (Grinberg, 2011). It utilizes the computational power of end-users' computer hardware to perform mathematical calculations for the Bitcoin network to create and track Bitcoin. Users can use a web or mobile interface to earn and spend their Bitcoin and manage them via their personal electronic wallet. Although it receives a lot of criticisms (because of its safety, privacy, sustainability issues, and more), a growing number of local businesses now accept Bitcoin, expanding its application. However, credits used in timebanking (also called time dollars) are different from those currencies because time dollars are created and exchanged through social interactions and volunteer activities, which are valued only in the time it takes to perform them, as opposed to a conventional monetary value.

Still, the motivation and intention of utilizing technology in timebanking is similar to that in other currency systems with respect to increasing the efficiency of managing timebanking task transactions and credits. In addition, recent research on timebanking has tried to leverage technology benefits and opportunities by proposing the development of a central hub system in which different timebanks are linked and members can exchange services, and earn and spend time credits across borders (Huber & Martignoni, 2013).

However more important aim of timebanking is to build social connections among community members and meet a variety of needs, including but not limited to economic ones, whereas other systems of local currency, including Local Exchange Trading Systems (LETS) and Ithaca Hours, mostly emphasize economic exchanges. Within this perspective, survey studies (Collom, 2011) and interview studies (Marks & Lawson, 2005; Ozanne, 2010; Seyfang, 2004) have shown a positive relationship between timebanking and members' sociality.

Timebanks are one of a number of non-profit peer-to-peer exchange systems that offer many *social and practical benefits* to their members (Seyfang and Longhurst, 2013). Participation in timebanks increases volunteerism as well as fostering richer social networks, enhancing sense of belonging in the community, and accruing social capital.

Motivations for participation in timebanking activities are slightly different among timebanks (Lasker et al. 2011). Some members seek to meet their economic needs while others find social connection and engagement to be the primary reasons of their timebank usage. Membership diversity is regarded as one of the main challenges in most timebanks, along with other challenges including member involvement, funding, and recruiting new members (Collom et al. 2012). Therefore, founders and coordinators in timebanks are constantly finding ways to increase participation of existing members and recruit new members in the local community who have different skills, strengths, services, and motivations.

## Affordances of Mobile Technology

The recent report indicates that 56% of American adults are now smartphone users and the number of smartphone adoptions has steadily increased across different age groups since its first introduction in mid-2007 (Smith, 2013). A growing number of people are utilizing their smartphones as portable computers, spending a lot of time using them for certain tasks that used to be done on the desktop PC (Karlson et al. 2009; Jara et al. 2014). This is because of the fact that smartphones not only incorporate benefits from desktop technology, they are also highly personal as people carry their smartphones with them most of the time (Geser, 2004).

Among a number of affordances of mobile technology, increased *mobility* and *immediacy* (Leung & Wei, 2000), have been long studied and widely acknowledged by researchers and practitioners. First, the principal advantage of mobile technology is increased mobility (Sarker & Wells, 2003). It transforms both time and space (Green, 2002), meaning that it allows people to access services wherever they go and transcends limitations of geography and distance when digitally communicating with others. Second, immediacy refers to the quality of bringing one into direct and instant involvement with something (e.g., entities, events, actions, etc.) in somewhat more time-critical situations or conditions (Anckar & D'Incau, 2002). When it is linked to mobile technology, immediacy usually pertains to how fast one could meet his/her expectations in terms of obtaining or accessing information in a particular situation or context. Indeed, these two affordances have shown a lot of technological and social impacts on people with respect to facilitating telecommunications and information access as well as connecting to and interacting with others (Beale, 2009).

When we consider these two affordances in a local community context, we can imagine many usage scenarios. For example, a local citizen consumes information pertinent to a local community and interacts with any local content through their mobile device whenever he or she wants. Mobile phone usage has penetrated into local communities. As mobile phones have become indispensible part of people's daily lives, a growing number of people use their device to consume local community news or events information and feel that the mobile device helps them keep up with information about their local community (Purcell et al. 2011). It is not surprising to see that people simply open up the applications and easily get the locally relevant information (e.g., news, events, foods, entertainment, etc.) while they are on the go.

Notably, this suggests some opportunity; for example, various types of local community information (e.g., news, events, meetings, etc.) will be accessed through mobile applications when requested, and people can also create new content by themselves and share it with their friends or the public through emails or other social media channels. Similarly, a previous research report indicates the positive relationship between the level of one's mobile technology use and engagement in civic mobile applica-

tions (Horning et al. 2014). For example, there have been a number of research studies aiming at utilizing mobile technology in the context of local communities in different manners. Some examples include *Discussion in Space (DIS)*, which is a feedback platform utilizing large screens to advertise community relevant questions and issues to the public and mobile devices that allow local residents to easily add their thoughts about those local questions and issues (Schroeter, 2012). *Lost State College* which the mobile tour application that presents local historical landmarks (Han et al. 2014a) by providing an interface to allow local residents to augment additional stories and personal experiences to the landmarks, making them more interactive and dynamic local places on their mobile device. *Local News Chatter* is the first smartphone application that provided an algorithm to filter and associate local tweets that are relevant to local news topics, where the aggregated news and tweets are then presented in a tag cloud (Han et al. 2014b).

Similar to the goals of the aforementioned projects, we aim at exploring community awareness and participation specifically in a timebanking context leveraged by mobile technology. Apparently, timebanking is local volunteer activities and based on volunteer activities and face-to-face and mutual interactions. In this sense, we strive to explore and articulate the opportunities as well as challenges of mobile technology intervention to timebanking space. We would also like to investigate social connections and interactions that could be formed and maintained by people in a same community.

### Timebanking and Mobile Technology

The idea of leveraging mobile technology in timebanking has already existed before; for example, Castolo et al. (2004) report development of a system prototype, emphasizing mobility, to support health care-related timebanking in Europe. Up to now, however, that idea has not been further developed, because timebanks have lacked the resources to develop mobile infrastructure.

According to the discussions with founders and coordinators in major timebank organizations, a shortage of funding software developers has meant that timebanks have not come close to keeping up with the growth of mobile technology (Bellotti et al. 2013). However, they regard access to timebanking through mobile devices as an urgent need, to increase interactions among members and attract more participants. Due to the overwhelming interest in adopting mobile technology, a number of studies have recently proposed the technical and social opportunities of leveraging mobile technology to timebanking. For example, Carroll (2013) presents a set of scenarios of mobile timebanking, emphasizing the notion of co-production in which the provider and the recipient create and enact a timebanking service together. Bellotti et al. (2014) discuss the future potential of utilizing context-awareness in mobile timebanking to support and facilitate more dynamic and efficient timebanking activities. These research efforts have shed light on a lot of possibilities for the application of smartphone technology in the context of timebanking.

## TIMEBANKING SMARTPHONE APPLICATION

Our design approach is to leverage and extend back-end database services of existing timebanks. We are collaborating with hOurworld and have been developing and designing the mobile timebanking application through a series of discussions.

The information transmission between the server and mobile clients is processed by RESTful Web service (Representational State Transfer). The fundamental idea is that the server provides the APIs (Application Programming Interfaces) and information transmission is implemented through these APIs. The APIs are described in JSON (JavaScript Object Notation) format, which provides better and fast

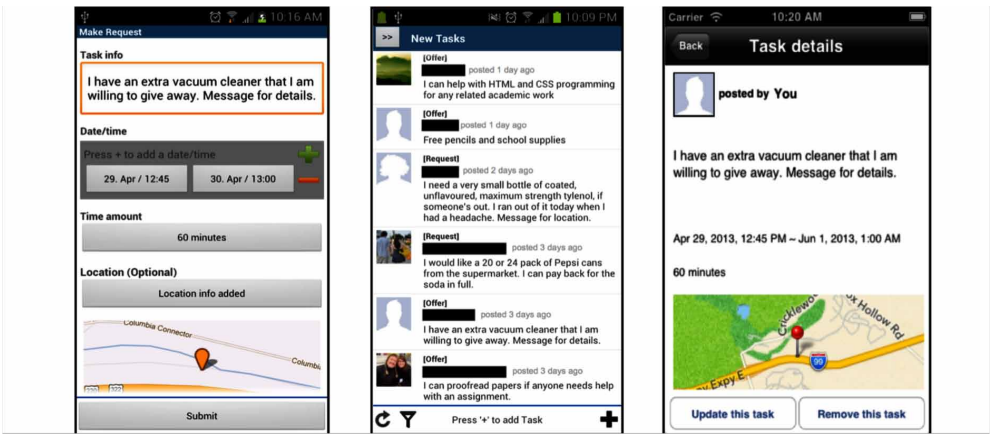
performance and is less resource-intensive than XML (Extensive Markup Language). Mobile clients initiate requests to the server, and the server processes requests and returns appropriate responses through the APIs. Then the clients receive them and display on the device properly. They also cache the data received from the server, reducing redundant and unnecessary data transmission. In this sense, all transactions and activities will be stored and logged in the server database.

The smartphone timebanking application incorporates synchronous interaction and location sensing as background services. Thus, it supports constantly checking for changes and updates both of incoming data streams and the device's current location as a background service. They provide notification messages without requiring the launch of an application, and filter information displays by location. Such features enable synchronous interactions that are also highly efficient. For example, the user can check a list of service requests from his or her neighbors, and the list presentation can be filtered and prioritized by where the user is current located; a request made minutes before for a quart of milk from the next-door neighbor would be prioritized very high if the user was standing in the grocery store.

The user volunteers for a request they wish to and are able to satisfy by selecting it. If the user is in the market, the user can choose the "buy milk" request from the current list. The application constantly polls responses to service requests through a background service; therefore, when the application confirms that a request has been selected, by communicating with the server through APIs, a notification message will be pushed the user who originally issued a request (e.g., I am bringing you milk and should arrive in ten minutes).

Figure 1 illustrate the design of the timebanking application. There are various types of information that a user could add, such as a title, description, preferred date and time frame, estimated time to complete the task, and task location. After the task is posted, other users can access a list of tasks and see detailed information for each task. In addition, a built-in messaging function was also designed to support text-based communication between two users, allowing them to set a schedule, negotiate timebanking activities and so on. If available, users can also communicate via email exchanges. Once the task is completed, the task requestors will be able to provide a satisfaction rating and additional comments for the job to support a reputational aspect of timebanking activities.

*Figure 1. Screenshots of the timebanking smartphone app running on both Android and iOS platforms (names anonymized): Add task view (left), task list view (mid), and task details view (right)*



The application supports the notification feature that allows users to receive a notification for any incoming messages from others or status updates of their tasks in near-real time. Users can also access their task history and profile information.

## USER STUDY

Our local community is a small university town located in the Northeastern US with students and local residents. We recruited 32 young university students via classroom announcements, the university research website, and word-of-mouth. In particular, we chose students as participants because they are one of the populations that most timebanks are hoping to engage, where a timebanking smartphone application would be most attractive to and whose participation a timebanking community would greatly benefit from. We have previously described that timebank members are disproportionately single, Caucasian, and highly educated elderly females. Thus, our focus is to explore experiences of mobile timebanking from the young adult population and articulate feasibility and usability issues that could be addressed and applied in existing timebanks in the near future.

### Procedure

Our research team introduced the notion of timebanking to participants at the beginning of the study. The study consisted of three steps: a pre-study survey, a five-week application use, and a post-study survey. First, participants received an online survey questionnaire, consisting of their smartphone usage to understand their technology affinity and two scenarios of mobile timebanking activities (Table 1) to set their expectations and then answered questions, reflecting their initial attitudes toward the concept of mobile timebanking (We utilized a Likert scale of 1 to 5, where 1 = *Strongly Disagree* and 5 = *Strongly Agree*).

Second, after the pre-study survey, participants were instructed to install the application on their smartphones (either Android or iOS). We provided them with the application download link. During five weeks, we encouraged them to post freely while they used the timebanking application. There were no additional requirements. Moreover, participants were allowed to post requests even if they did not have time credit to spend. In fact, to some extent, many timebanks allow minus time hours especially for the first timebank members. All transactions and usages of the timebanking application are logged in the server.

After five weeks of application use, participants again were asked to completed an online post-study survey, which included participants' overall experiences (e.g., reasons for posting and taking a task, how the task was completed, etc.), their satisfaction after completing transactions, familiarity with the person involved in the transactions, and open-ended questions including sense of community attachment and challenges encountered. Note that, although the practice of managing time dollars is an important issue in any timebanks, it is beyond the scope of this research inquiry as we focus on the design of mobility to enhance timebanking practices.

*Table 1. Mobile timebanking scenario used in the pre-survey*

| |
|---|
| Mary was in the market to buy some groceries. While she was shopping, she quickly checked Mobile Time Bank requests. One of her neighbors, John, had posted a request for a quart of milk an hour ago. She would be driving right past his home anyway. Since she already knew John, she called him up and told him the milk was on the way. She also accepted the request in her Mobile Time Bank app. She had a brief chat with John while dropping off the milk. As she left, she felt good about helping someone, but also was struck by how easy it was to do, earning time bank credits as well. |

## Participants

Of 32 participants, 21 were males and 11 were females. Seven participants were under 20 years old, and the rest were in their low 20s. All participants have their own smartphone and are familiar with using the smartphone for different activities such as using social media, web-surfing, emailing, gaming, and so on.

According to the pre-study survey results (i.e., mobile timebanking scenarios), we found that participants' first impressions and attitudes toward the timebanking application were quite positive. They considered using the application for the purposes described in the two scenarios to be slightly appealing (Mean: 3.5; SD: 1.0). On average, they agreed slightly that this study would give them opportunities to meet new people or make friends (Mean: 3.5; SD: 0.9) and they were more convinced that the application would provide opportunities to use their skills, knowledge, or resources to do something for others (Mean: 3.9; SD: 0.7).

When we asked them about motivations to join this study, their responses consisted of "altruistic reasons," including helping people in need (Mean: 3.5; SD: 0.8), gaining satisfaction from helping others (Mean: 3.4; SD: 1.0), or improving their local community (Mean: 3.5; SD: 0.7). Participants were, on the whole, not so interested in economic gain such as obtaining needed services (Mean: 2.7; SD: 0.8) and goods that they could not provide for themselves (Mean: 2.4; SD: 0.9).

Overall, although the participants had never heard of timebanking before, they seemed to be motivated to help and interact with others and were generally interested in using timebanking with their smartphone.

# RESULTS

## Overall Timebanking Activities from the Smartphone Application

During a five-week study, participants posted 116 tasks (66 requests and 50 offers) and completed 51 tasks (29 requests and 22 offers; 44% of the total tasks) as shown in Table 2. After the study was finished, all authors coded the tasks and classified them into nine groups (including "others").

For this analysis, we did not specifically consider whether the tasks were categorized into either requests or offers (where request means "I need some service" and offer means "I can provide some service"), because our intention here was to explore different types of tasks and to find if there were some tasks particularly

*Table 2. Overall activities in mobile timebanking by university students (sorted by the number of posted tasks)*

| Category | Posted (Count) | Completed (Count) | Completion Rate (%) |
|---|---|---|---|
| Free Stuff | 17 | 11 | 65% |
| For Sale | 17 | 7 | 41% |
| Proofread | 14 | 7 | 50% |
| Tutoring | 14 | 2 | 14% |
| Buying | 13 | 6 | 46% |
| Transportation | 13 | 4 | 30% |
| Social Contact | 11 | 6 | 54% |
| Info. Inquiry | 9 | 6 | 67% |
| Others | 8 | 2 | 25% |
| **Total** | **116** | **51** | **44%** |

pertinent to timebanking with a smartphone. We focus on describing each category with examples of the posted tasks and detailing more stories about each category.

Overall, participants requested or offered a variety of tasks. "Free Stuff" and "For Sale" were the most common posts; however, "Free Stuff" had a higher completion rate (65%) than "For Sale" (41%). There were several examples in "Free Stuff," including giving away some textbooks (e.g., "Free security in computing textbook.") or extra items (e.g., "I have an extra vacuum cleaner that I am willing to give away."), or offering free food (e.g., "I will bake a cake for you. Message for details."). As those tasks in "Free Stuff" seemed quite easy to take and complete, it might have a high completion rate. Examples in "For Sale" include, "I need a calculus book by James Stewart 7e. I will buy it." In general, tasks or services which deal with items (e.g., exchange, sell, give away) are common in other existing timebanks (Collom et al. 2012) even though they are not strictly valuable in terms of time, and our study showed similar results.

A number of tasks were posted in "Transportation." Several participants looked for and were willing to offer a ride (e.g., "Heading to Target in an hour, anyone needs a ride?"), but only 30% of them were completed. For "Buying," a few participants asked someone to purchase some goods or items for them (e.g., "I would like a 20 or 24 pack of Pepsi cans from the supermarket. I can pay back for the soda in full.") or asked if anyone needed something because they would be there shortly (e.g., "I am going to Walmart this afternoon. Message me if you need something."). Nearly half of the posted tasks were completed (46%).

Tasks in "Social Contact" are especially pertinent to a young adult population because most of them referred to playing video or computer games together online. While the tasks in this category are usually related to offline meetings or gatherings (e.g., potlucks, picnic, etc.) in traditional timebanking, our participants showed somewhat different but unique activities that reflect a characteristic of a young adult population. Examples include, "It would be nice to have someone to play games with on the internet tonight. feel free to message me first." More than half of the tasks in this group were completed (54%).

Among all timebanking tasks posted, in particular, those in "Free Stuff", "For Sale", "Transportation", "Social Contact" are consistent with transactions documented in prior work (Collom et al. 2012), indicating timebanking in young adults on smartphones still fosters traditional timebanking transaction types.

We also note that the tasks in "Proofread," "Tutoring," and "Information Inquiry" are highly pertinent to university students, indicating that our participants appropriated the timebanking smartphone application to meet their academic goals. Tasks in "Proofread" (e.g., "I can proofread papers if anyone needs help with an assignment.") and "Tutoring" (e.g., "I am good at Math until 140 course level and can help you if you need help.") were examples of this. While the completion rate in "Proofread" was high (50%), we found that in "Tutoring" was quite low (14%), perhaps because tutoring requires offline interactions whereas proofreading can be done remotely. Some participants used the application for "Information Inquiry." We found that most tasks in this category were about students' major or career; for example, "I would like an IST minor, please send me a detailed description of what exactly their degree is and answer any questions I might have since I am thinking about minoring in it." Over half of them were completed (67%) again, perhaps because those tasks also can be easily done via online communications.

In summary, the results show that young adults used the mobile timebanking application in many different ways. All of the tasks were the ones observed in non-mobile timebanking contexts, yet some of them (e.g., "Proofread," "Tutoring" and "Information Inquiry") seem to be highly pertinent to participants' school life, which are not found to be highly popular in conventional timebanks (Collom et al. 2012). It is also important to note that young participants engaged in timebanking quite actively,

providing the fact that active timebank members (who regularly engage in timebanking) tend to complete 5-7 services per quarter (which is 1-2 service(s) per month; Collom, 2012). This also indicates a possibility of high engagement by young populations when mobile timebanking is introduced.

## Potential Opportunities of Timebanking from the Smartphone Application

In this section, we present the study results within the lens of the three affordances of smartphone technology on timebanking, including reducing transaction time, supporting location and time-sensitive timebanking activities, and coordinating in real-time.

### *Ability to Reduce Transaction Time*

All the timestamps for task transactions were logged in our database; thus, we were able to calculate the sensitivity of time in task completion. As shown in Table 3, if we assume that participants regularly updated task transactions during the study, most completed tasks took less than a week. Especially we found that those in "Buying," "Proofread," and "Free Stuff" were completed within three days on average. It is also worth noting that the minimum values for each category were mostly less than one day (for example, the minimum results of "Buying," "Proofread," "Free Stuff," and "For Sale" are less than a day), indicating some participants utilized the smartphone application to meet their needs or help others quickly. This seems to be due to greater accessibility as some participants checked the list of posted tasks regularly using their smartphone:

*I tried to browse the app regularly to see what sort of things people had posted. (P12)*

It is important to note that, according to timebank coordinators, most traditional timebank members tend to report task completion several days later. From the discussions after the study, the coordinators and system developers of timebanks agreed with the point in which completing a task within two days from the original posting date does rarely happens in practice of traditional timebanking. We noted that this result might be influenced by the notion of *mobility* and *immediacy* of mobile technology, because participants received the notification about the updates from the application and were able to report the hour right from it.

It has been well known in timebanking communities that many timebank members do not report hours right after they complete the service or task because computers are not always available or accessible. Also in many cases, they forgot to report hours even if they completed the tasks. Reporting hours through

*Table 3. Average time-to-task-completion calculated from the timestamp (unit is day; sorted by mean; "Others" excluded)*

| Category | Mean (SD) | Min | Med | Max |
|---|---|---|---|---|
| Buying | 2.8 (2.6) | 0.2 | 2.6 | 7.3 |
| Proofread | 2.9 (2.5) | 0.9 | 1.9 | 7.9 |
| Free Stuff | 3.0 (2.7) | 0.9 | 1.9 | 7.3 |
| Social Contact | 3.5 (2.1) | 1.0 | 2.7 | 6.2 |
| Transportation | 4.0 (2.5) | 1.0 | 3.9 | 7.3 |
| For Sale | 4.1 (3.9) | 0.5 | 3.5 | 12.3 |
| Tutoring | 4.4 (2.0) | 2.9 | 2.9 | 4.5 |
| Info. Inquiry | 7.1 (5.0) | 1.1 | 6.6 | 13.5 |

the mobile application was designed to be easy, and it seems participants found in the same way too. In this sense, timebanking with a mobile application seemed to facilitate managing timebanking activities and transactions quickly and conveniently.

### *Ability to Post and Complete Location and Time Sensitive Tasks*

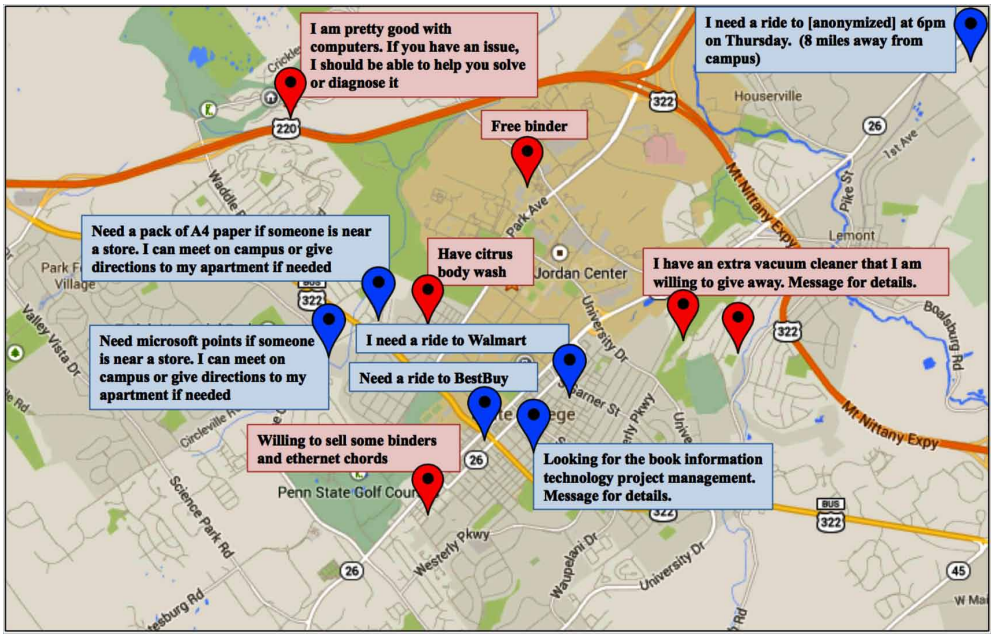
To measure locational aspects of task transactions, we collected detailed stories of each completed task from participants during the post-study. We inductively coded and operationalized each story based on *how* and *where* the available task was accessed and taken by participants. Through this process, we were able to analyze if each task contained time- and location-sensitive components. We decided to consider a task as time- and location-sensitive if it was completed because (1) the task taker was in or near to the place that had been specified in the task description and (2) both the original task requestor and the taker reported the task as being completed in two days.

Statistically, we first found that the total number of fine-grained timebanking activities was 21 (18% out of a total of 116) for all tasks and 7 (14%) for the completed tasks. Those were from the three categories: "Free Stuff," "Transportation," and "Buying." Some of these timebanking posts were shown in Figure 2. Although some items in those categories can be viewed as conventional timebanking tasks (Collom et al. 2012), their management and scheduling seemed to be influenced and facilitated by the smartphone application.

Here we present two detailed usage examples (which was completed in a day) from "Buying" and "Transportation." First, in the "Buying" category, there was a task involving buying items named:

*Need a pack of A4 paper if someone is near a store. I can meet on campus or give directions to my apartment if needed.*

*Figure 2. Examples of posted tasks during the study. Blue pushpins indicate "Requests" and red pushpins indicate "Offers." Some of the task examples are more location and time sensitive.*



After few hours, one participant took this task, because he was at the location specified in the task description:

*I took this task because I saw it while I was at BestBuy looking for something else. I was able to pick up A4 paper and give them to him on campus later that day. He paid me back. (P24)*

The task taker (P24) did not go to the store just for the purpose of timebanking; therefore, it is worth noting that completing this type of task requires a number of pre-conditions including (1) the taker was at the right place to start it and getting to the right place to complete it was not inconvenient, (2) he found the task from the application, (3) he had enough money for this, and (4) he was willing to take the task. Consequently, we found that both participants felt great about this task completion because it was easy for the task taker, and valuable to the recipient:

*Very satisfied with this task. The task was convenient to complete because I was already at Best Buy. (P24)*

Another example is from the "Transportation" category, in which there was a case for offering a ride. One participant posted a task (on Thursday morning) for a ride to the place located around 8 miles away from the university:

*I need a ride to Bellefonte at 6pm on Thursday. (P1)*

After few hours of posting, this task was taken by someone who actually lives in that area:

*I live in Bellefonte and found that someone needed a lift, so I sent a message to him and we exchanged phone numbers to meet up. (P12)*

After they completed the task, both participants showed a high satisfaction, because one participant (P1) was able to have a free ride and the other participant was able to help and offer a ride easily (P12):

*We had to change times to meet, but I think it worked quite well. (P12)*

Another salient opportunity that we could see from these examples is the way that the timebanking application allows one to provide a service to another as a *secondary* task. Busyness has been identified as an obstacle to participation in timebanking (Lasker, 2011); therefore, this 'altruistic multitasking' may enable greater participation by busy people. Some participant comments supported this aspect:

*I found that factors such as how busy I was with other things and if I needed anything done at the time affected how willing I was to help other people. (P11)*

*I feel like it would contribute to the community by helping people with chores or things that they need, but do not have time to get or do it for themselves. (P5)*

### Ability to Coordinate in Real-Time

User study results also showed that timebanking with a smartphone application enabled near real-time coordination and communication among participants. We found that a total of 24 participants exchanged text messages during the study. As we closely looked at those messages, there are some overlapping cases where participants asked more details about the task posted, coordinated a time to meet, exchanged additional personal information (e.g., phone number, if both participants are willing to), and so on. According to participants, it seems that many of them found the messaging feature useful:

*The messaging function was useful to sort out specific details about the tasks that couldn't be described in the task name. (P17)*

*I used this quite extensively to set up meeting times and solidify details otherwise unmentioned in the task. (P29)*

There was one usage case in which two participants exchanged messages for task management while they were at random places such as café or in transit. Figure 3 illustrates the flow of message exchanges between two participants. Here we would like to emphasize that how a timebanking smartphone application facilitates communications between two participants. It allowed them to set up the date/time and the location to complete the task as quickly as possible. A similar practice could occur within web-based transactions; however, mobile timebanking facilitates communications among participants by allowing them to get notified of and exchange messages in real time because a lot of people nowadays have their mobile device with or nearby them. These all make the whole timebanking process fast.

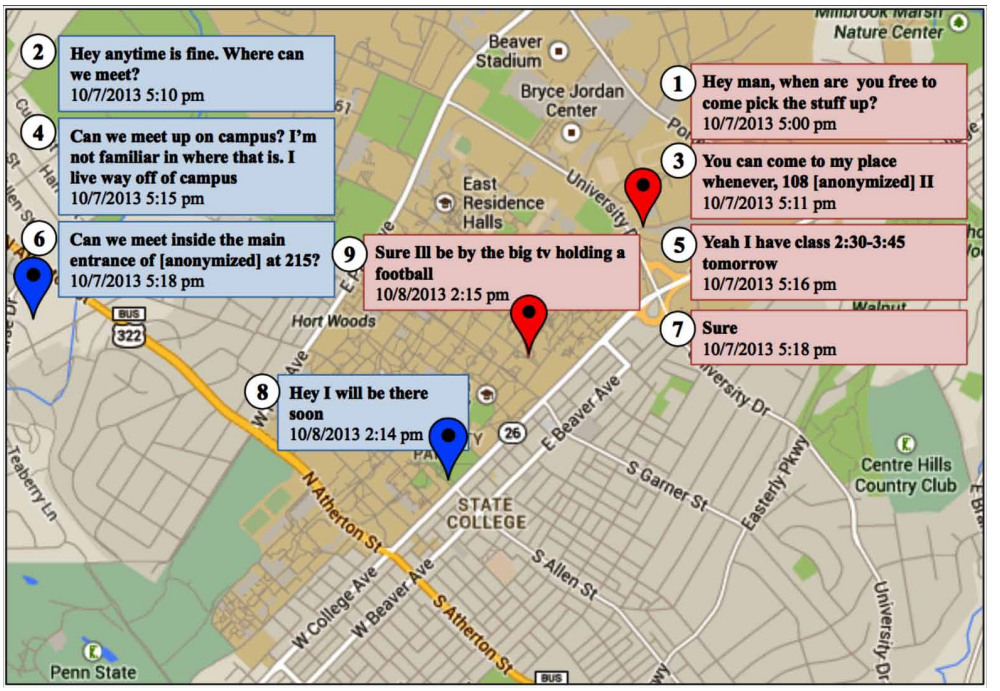
In summary, the usage results suggest opportunities in finding, accessing, managing, and completing timebanking activities and transactions leveraged by *mobile* and *immediate* aspects of mobile technology. From the results, we could argue that the timebanking smartphone application used by young adults creates new possibilities of increasing task diversity as well as facilitating task transactions and management.

## Activity and Social Interaction

### *Individual Interactions and Connections*

The number of posted tasks varied a lot by participant (Mean: 5.2, S.D.: 4.7), where the highest number of tasks was 18 and the lowest was 1 (7 participants posted only one task during the study), and the median was 4.0. This result is consistent with findings in the

*Figure 3. Examples of message exchanges between two participants for coordinating time to meet (task category: free stuff)*



literature suggesting that there are always both active and non-active members participating in timebanking activities (Collom, 2011).

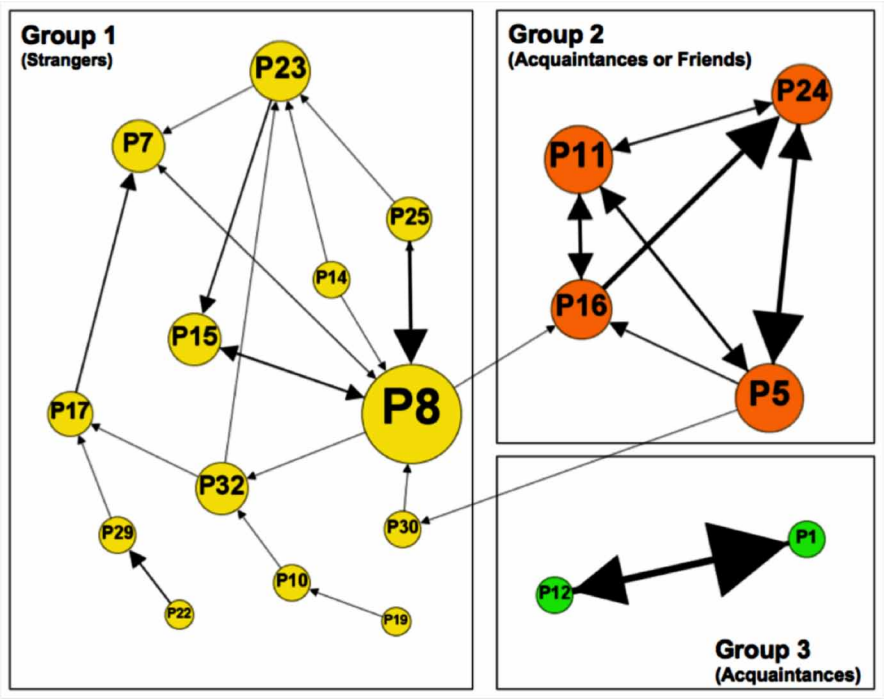
We examined how each participant interacted with others because timebanking depends on individual interactions and communications. We chose to use the level of *familiarity* as a potential variable because it is important especially for new potential timebanking members. To understand this, we collected the level of familiarity from participants during the post-survey, by asking them to indicate how familiar they were with other participants prior to completing a task, by choosing one of three options: *Friend*: I am very close to this user; *Acquaintance*: I know this user a little; *Stranger*: I did not know this user before. We then investigated how participants were connected with others based on the level of *familiarity* and the number of *completed tasks* between the two, to see how social relationships influence choice of whom to transact with.

We ran a social network analysis tool, Gephi (Bastian, Heymann, & Jacomy, 2009), to visualize all transactions (Figure 4). Among 32 participants, we found that all participants posted at least one task and 19 participated in at least one task completion (represented as 19 nodes). Other 13 participants were still in the middle of the handshake processes at the termination of the five-week study period (e.g., waiting for the task requestor approve a task, waiting for the task taker to complete a task, or waiting for others to take task requestor's tasks, etc.). Each node represents an individual participant, and the size of nodes represents the number of transactions with others. Each edge represents one or more transactions between the two, and the width of edges represents both familiarity and number of transactions. The edge width is calculated as follows: *width = (the number of transactions) X (familiarity score; from 1 to 3)*. The sizes of arrowheads on the edges indicate the number of times the one they point to was the recipient of a service. We then identified three small communities in the whole network. Each group is colored differently in the figure. The nodes in Group 1 (yellow) are strangers, those in Group 2 (orange) are either acquaintances or friends, and those in Group 3 (green) are acquaintances.

Figure 4 highlights two observations. First, participants showed different preferences when interacting with others. On the one hand, no participants in Group 1 had any preexisting ties with each other before taking part in this study. However, many of them interacted and completed tasks with at least two other participants, and some of them completed multiple tasks with several other participants (e.g., P8 has 7 links and P23 has 5 links). People in timebanks that resemble P8, with several connections to others in an interconnected group as well as with those in a different group, would be able to bridge holes in the overall network. According to Burt (2010), such people see opportunities first and distribute innovative ideas to everyone else; therefore, it would be desirable if such people could be recognized and promoted in the timebanking network to increase and facilitate interactions. On the other hand, most of the participants in Group 2 tended to interact with others (sometimes multiple times) with whom they had preexisting ties (either high or mid familiarity between the two), and two participants in Group 3 only interacted with each other.

Second, we found a number of reciprocated interactions (a participant helping another in return after previously being helped by them). Reciprocation is an important concept in timebanking because it is closely related to the formation of social bonds (Putman, 2000). It is more obviously shown in Group 2 and 3, but there are some connections in Group 1 as well. One particular finding is that, although most connections were not reciprocative, demonstrating the effectiveness of the "pay-it-forward" timebanking model, some participants seemed to gain more satisfaction when they had mutual contributions. In the previous section, we described one example of the completed tasks in "Buying" between the two participants (P8 and P15) who had not had preexisting ties. We

*Figure 4. Social connections among 19 participants (who completed at least one task) based on the number of completed tasks and familiarity between two*




noticed that P15 reciprocated by helping P8 on proofreading a writing assignment a few days later:

*I am good at proofreading papers and I feel great that I could help him out this way for his help with Walmart. (P15)*

These reciprocated interactions imply two insights. One is the creation of a new social relationship. The previous case between P8 and P15 is such an example where both came to know each other while completing multiple tasks:

*I will say Hi to Rick if I see him again and spend some time talking with him. (P15)*

Another is about reinforcing existing relationships. This inference is especially supported by one completed task *"I need a ride to Bellefonte at 6pm on Thursday."* between P1 and P12 in Group 3 (which was previously discussed). They already knew each other but were not well acquainted enough before taking part in the study. When P1 first took the task posted by P12, one of the initial actions was to exchange their phone numbers. While communicating and interacting to complete the tasks, they became more familiar with each other. The following are each one's comment about the other:

*He is a fun person to talk to. (P1)*
*I feel more connected to this person than before. We text and hang out now. (P12)*

So the reciprocal interactions that we see in Group 2 and 3 are the reinforcement of ties that already exist. As evidenced by their greater thickness, preexisting ties seem to

make it easier to respond to others' posts. And dyadic reciprocity also correlates highly with a preexisting tie, even to the point of exclusiveness and isolation among people who interact a great deal as depicted in Group 3. This is an area of interest for further study and analysis.

### *Sense of Community Attachment*

One particular aspect of sense of community attachment was the increased awareness of local community in regard to sharing various types of timebanking tasks, which complies with what timebanking studies have reported (Seyfang, 2004). For example, participants were surprised by the fact that there were a lot of tasks posted by others and mentioned that they were pleased to discover that there were many people willing to help each other in this community:

*It has definitely given me more confidence and trust in the community because now I feel like the community would be there to help me when I need any help. (P8)*

They also mentioned that timebanking helped them get a clearer idea of people's general feelings toward one another in the area where they live:

*I think this app could contribute to the community as a way to trade items locally, as well as a way to network with people inside the community you normally wouldn't have met. (P16)*

Some participants also indicated that this study helped them gain self-esteem and now believed that helping others was not as complicated as they had expected. This perspective is also consistent with one of the positive outcomes of timebanking, which refers to the realization of one's own unique skills that can be used to help others and for volunteerings in the community (Coleman, 1998):

*I found my most valuable skills are writing related and I could help people with this more and more. (P32)*

A number of participants also expressed that they wanted to give back to the timebank community after they received successfully completed services. As previously discussed, reciprocated interactions create and strengthen bonds among members in the same community, enriching social networks. Participants mentioned that mobile timebanking would allow local people to engage with each other and help each other even for the simplest tasks. This would lead to a growing sense of caring and respect for community members because local residents will be willing to help each other out and to inspire others to help people in the community without monetary compensation.

Overall, these comments suggest that the experience greatly exceeded participants' initial lukewarm expectations of mobile timebanking as well as corresponding with positive outcomes of timebanking in general. Therefore, we can say that the idea of augmenting a smartphone platform into timebanking makes sense for this young student population.

## Usability and Challenges

We investigated some usability aspects of the mobile timebanking application in the post survey. Most participants said that they found the design of the application straightforward and easy to understand. Perhaps this is because of the fact that the application has been designed and implemented through a series of investigations and discussions with an existing timebank. Some participants mentioned they liked the idea of extending the idea of timebanking into a mobile platform:

*Conceptual currencies have always been a really interesting concept to me, so wrapping my head around the time currency concept was entertaining. There was nothing particularly challenging about the experience from the application. (P12)*

*I personally didn't find any challenges, I felt it pretty easy to use, and it didn't take much time to figure out. (P16)*

Participants' positive comments about the application show a potential to be an extension of an existing practice of timebanking for current timebank members.

At the same time, we also found some challenges (which are not necessarily related to usability issues) that participants encountered during the study. First, participants faced some difficulties when communicating with others. Some of them actually complained about the low response rates from others, leading to the situation in which the tasks could not be completed. Because all transactions and interactions were done voluntarily, it was relatively easy for anyone to simply ignore the calls or messages or to break up the connections without any notice. Participants reflected on this issue:

*I was frustrated, because one person didn't end up completing my task, even though I messaged him multiple times. (P8)*

*Everything was good, but some people were not good at communication than others. (P14)*

Second, some participants mentioned that although they were able to see a number of available tasks, yet there were still not a lot of tasks that they could actually perform due to a lack of resources (e.g., car for transportation, computer programming skills for tutoring, etc.). Also, because all participants were students, the types of tasks might not be diverse enough:

*It seems like a lot of participants are looking for a certain text book or a certain set of skills that I don't have such as graphic design, programming, etc. (P17)*

It is worth noting that those two challenges seem to be consistent with what has been reported in other timebank studies that could limit participation. For example, in the national survey of timebank coordinators, "contact difficulties" and "unavailable desirable service" are identified as one of the top challenges (Collom et al. 2012). Perhaps they are fundamental issues in timebank communities. However, the first challenge could potentially be mitigated by adding additional awareness features to make the transaction process more transparent. The second challenge might in part be addressed by having more timebanking members with different talents and specialties. Most participants in our study also believed that more interesting and various types of tasks would need to be posted, if timebanking is to become more widely adopted.

# DISCUSSION

## Research Contributions

Earlier in this paper, we have indicated that membership diversity and limited software capability have been considered major challenges for many existing timebanks. We argue that utilizing smartphone technology for timebanking would mitigate them, because more people are adopting smartphones. Our study results suggest that smartphones would allow flexible management of tasks and communications on a personal device.

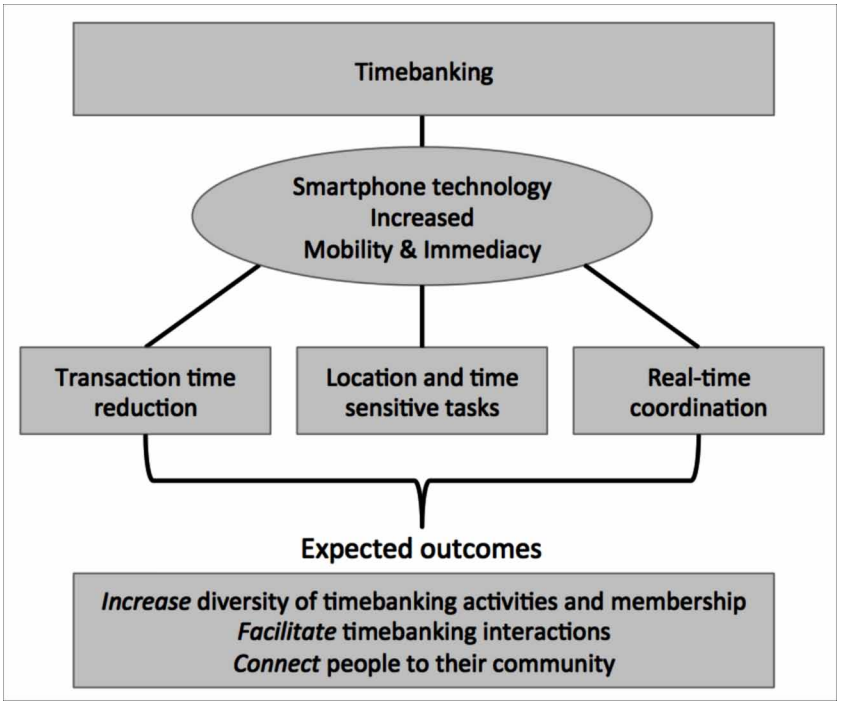
The contribution of this paper is threefold. First, our study showed how the young adult population, who had not heard of timebanking before, used the timebanking smartphone application. According to participants, using the timebanking application was quite straightforward and easy. Complying with their initial motivations of using the application from mobile timebanking scenarios, they posted and completed a number of different types of tasks and interacted with others during the study. Moreover, some tasks in "Proofread," "Tutoring" and "Information Inquiry" seemed to be highly relevant to their school life.

We found a number of tasks in the "For Sale" category were posted and completed. One might raise a question about this category

that violates the no goods rule of timebanking because exchange of items of monetary value could threaten timebanking's so far tax-exempt status. Collom et al. (2012) also note this perspective, and according to them, it appears that members donate or sell their goods to their timebank, and staff members price them into hours rather than directly exchanging goods or items by themselves or using money. Some timebanks manage an item shop from which members can buy items only through their time dollars. We believe once the smartphone timebanking application is integrated with existing web-based platforms and is supervised by timebank organizations, this issue could be handled in a similar manner.

Second, while some tasks were included in existing practices of timebanking activities, some other tasks seemed to be influenced by smartphone affordances. We have identified and presented three affordances of smartphone technology on timebanking, namely, reducing transaction time, supporting location and time-sensitive timebanking activities, and coordinating in real-time based on the usage data (see Figure 5). Regarding transaction time, many timebanking tasks and transactions were completed in a week, and some of them were even done in two or three days, which we believe seemed to be influenced by mobility and immediacy characteristics of the smartphone. Our discussion with timebank administrators and coordinators indicated that timebanking with a mobile application allows users to manage timebanking services and report completed tasks quickly and easily, compared to those activities through a web-platform. For location and time-sensitive activities, our analysis indicated that around 15% of the posted and the completed tasks could be considered as time- or location-sensitive; for example, one participant found a task through the application while he

*Figure 5. Timebanking leveraged by smartphone technology and its expected outcomes to people and communities*



was at the store and was able to complete that task, making both the task requestor and the task taker satisfied. For real-time coordination, we found that many participants utilized a messaging feature quite a lot to ask more information about the task, set up and negotiate time to meet (if the task requires offline interactions), exchange additional information, and so on. This messaging feature along with notifications allowed participants to manage and complete their timebanking transactions easily and quickly.

These more smartphone-compatible timebanking activities ask us to think about applying context-aware and adaptive system design (Bellotti et al. 2014). One possible design idea is to proactively target people with task recommendations, based on their present situation. For example, a timebank member might be targeted for notification of a tasks involving buying and delivering an item when s/he is at Walmart. Additional opportunities include recommending the best available person who can complete a task to its owner (who can then decide to make a personal request), or providing expected completion time based on a history of members' task completions and their specialties to allow flexible management of task and service transactions.

Third, we investigated whether extending timebanking into the smartphone platform shows similar outcomes to traditional timebanking with respect to social connection and interaction, and a sense of community attachment.

Regarding the first perspective, we presented the analysis of the completed tasks based on the level of familiarity. We found that the number of completed tasks varied a lot; for example, some participants interacted with others, whom they had not known previously, once or even multiple times, while others interacted (sometimes exclusively) with people whom they had a preexisting tie with. We also observed several reciprocated interactions, which either created or maintained (or both) social bonds that could be further developed into social relationships. This analysis suggested the interesting idea where there should be systematic support for active members (like P8 in our study) to make their activities more visible so that others can recognize, applaud and learn from those members. Especially, for new members, this design would help them to see how active timebanking members can be.

For the sense of community attachment, participants mentioned that they were aware of and surprised by various types of tasks and services that other participants shared, as well as their willingness to help others. Design efforts to increase the visibility of different and unique timebanking-related information, such as presenting most active members or popular posted and completed tasks on a monthly basis, and so on, would increase the recognition of the value of timebanking by both existing and potential members.

## Limitations and Future Work

The study results described and discussed in this paper were based on the usage and experience of young university students. We acknowledge that the results in this paper cannot immediately be generalized to other populations or existing timebanks, because of the limited number and particular demographics of our participants and relatively short-term application usage. Existing timebanking members might show different usage of the timebanking application and user experiences. More extensive usage of the application as well as the time dollar usage patterns would be far better articulated in a larger study. We are also interested in investigating additional affordances of mobile technology and their impacts on timebanking as well as evaluating their relationships.

Also in the social interaction analysis, we only considered the initial familiarity level between two participants prior to completing any tasks. But, clearly, there might be some changes of familiarity between two participants after they complete some tasks or interact with each

other. This study may not be enough to allow a relationship to grow significantly. Because we are interested in exploring the influence of relationship changes on people's task and social management, we plan to investigate this through long-term and extensive user studies in the future with one or more real timebanks.

We are in the process of revising the application, based on participants' feedback and lessons about further design opportunities. Because our timebanking smartphone application is now being augmented to integrate with existing timebank infrastructures to be managed by real timebank communities, we have deployed the application to their affiliated timebanks. As existing members of timebanks have shown great interest in having a mobile version of timebanking, we believe this will allow us to investigate the effects of timebanking with a smartphone platform in broader ways.

## CONCLUSION

Our study participants were positive to the idea of timebanking and expected to use the timebanking application in the future, showing its potential to increase membership and service diversity. Our study suggests that timebanking on a smartphone platform will support existing timebanking transactions as well as creating more opportunities for users to provide or receive community-based volunteer tasks or services through greater accessibility to the application and through being able to take advantage of mobility and immediacy (i.e., being in the right place at the right time for certain tasks). Because a growing number of people are adopting smartphones, integrating timebanking services and activities with the smartphone application would attract more people to it. Like many positive or encouraging outcomes from conventional timebanking, smartphone-based timebanking shows great potential to foster community exchanges and create and reinforce social connections and social capital among members of a local community.

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