

TAMIES: A Study and Model of Adoption in P2P Resource Sharing and Indirect Exchange Systems

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ABSTRACT

Peer-to-peer indirect exchange services do not seem to have been as widely adopted as direct exchange systems. In order to understand contributing factors to this lack of adoption, we examined attitudes towards and usage of peer-to-peer resource-sharing sites among 37 residents of New York City, 9 of whom had previously used a peer-to-peer sharing site. To more deeply understand the role of trust on willingness to lend, we analyzed results from a survey with 195 respondents. Our findings show that people expressed concerns of violating norms of the kinds of objects suitable for sharing, potential risk involved with entrusting a possession to somebody else, and a dearth of the available items that would be most useful. Building upon previous technology acceptance models, critical mass theory, and prior research on peer economies, we propose a technology acceptance model for indirect exchange systems that includes generalized trust and ease of coordination. We discuss how monetary and non-monetary assurance structures might affect adoption.

ACM Classification Keywords

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Author Keywords

indirect exchange; sharing economy; peer to peer resource sharing; Peerby; Neighborgoods; critical mass; TAMIES; technology acceptance model

INTRODUCTION

The growing sector of peer-to-peer services that leverage the pervasiveness of online technologies to connect strangers to one another through exchange of resources – often labeled broadly as ‘the sharing economy’ – can be divided in terms of social exchange theory between systems of direct and indirect

exchange. Direct (or restricted) exchanges are those where two actors benefit each other from an individual interaction (such as services like Uber, TaskRabbit, and Airbnb). Indirect (or generalized) exchanges are those where each actor gives benefits to another but does not necessarily receive benefits back from the same actor [20] (such as Freecycle¹ and Couchsurfing²). For example, on Airbnb guests pay hosts directly for providing accommodation, in a direct exchange of resources. Whereas on Couchsurfing, guests do not pay their hosts for providing accommodation. Instead, hosts who provide accommodation can expect to be given accommodation in the future from another user of the service (and vice-versa), in an indirect exchange of resources. Previous research suggests that indirect exchange has greater potential to produce social outcomes than direct exchange [26], which could have positive effects on local communities. While peer-to-peer services that function on a model of economic exchange have thus far been most widely adopted, we were interested in understanding the wider potential of indirect exchanges services. As opposed to paying someone in return for a service rendered, an indirect exchange service would function *without* monetary transaction. Peer-to-peer sharing without reliance on monetary incentive is particularly important to examine in light of recent research on barriers to engaging in direct exchange services like Uber and TaskRabbit by members of disadvantaged communities [9, 37].

We examined the Technology Acceptance Model (TAM) [8] to understand adoption of indirect exchange services. TAM is a widely-used model for explaining adoption of computer systems that has been built upon and applied to different technological systems. Technologies that rely on the participation of multiple users for functionality, such as groupware [10, 22] or instant messenger [21], present distinct adoption challenges, since the experience of an individual user is necessarily dependent on the participation of others. Peer-to-peer sharing is similar in this regard, as users are necessarily dependent on one another to be both borrowers and lenders. The model includes factors of perceived critical mass, perceived ease of use, and perceived usefulness that influence a user’s intention to engage with groupware. However, based on previous literature on peer-to-peer systems [4], especially related to trust and safety [9, 37], we believe that there may be other

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¹<https://www.freecycle.org/>

²<https://www.couchsurfing.com/>

factors missing from the model that could contribute to TAM for peer-to-peer sharing systems.

We aim to identify the factors which may contribute to adoption of indirect exchange services. Given the potential positive impact on local community that could arise from indirect exchange [26], we chose to study the particular case of platforms that facilitate sharing physical goods with people who live near them. We chose to focus our study on physical goods because several companies have offered platforms for this type of exchange for nearly a decade, signifying its potential but also suggesting there might be barriers to adoption. Ecomodo launched in 2007, Crowd Rent and Share Some Sugar in 2009, and Thingloop, OhSoWe, and SnapGoods in 2010, though all of these sites have since shut down [14]. NeighborGoods, a website that allows people to post things that they own to lend to others, launched in 2009, a year after Uber and Airbnb. NeighborGoods still exists, but has not amassed the numbers of users as other peer-to-peer platforms. Peerby, a mobile application where people can post requests for items that they want to borrow to which other users can respond, launched in 2012 and reports to have 100,000 members in more than 20 European cities³, though adoption of this model has still been slow in US cities. We focused on Peerby and Neighborgoods (see Figure 1) as they are two currently active peer-to-peer resource sharing sites. At the time of writing, both are free to use without a transaction fee.

We are particularly interested in the role of trust in the perceptions and use of these systems. The concept of generalized trust captures the view that one can consider trust even when it is not in the context of “a particular person we know or at least have information on” [28]. Generalized trust has many outcomes and consequences including memberships in common interest associations and collective action [27, 28]. It is thus likely that the level of generalized trust will impact participation in sharing services that involve interaction with strangers [35].

To summarize, through an examination of two peer-to-peer resource sharing services, we aim to understand:

- What are the barriers for adoption of peer-to-peer resource sharing services?
- How do factors that contribute to adoption differ between lenders and borrowers of peer-to-peer resource sharing services?
- What role does generalized trust play in people’s willingness to engage in technology-mediated sharing of resources?

To this end, we conducted interviews with a mix of residents of New York City, including some who had previously used Peerby or NeighborGoods. A survey, deployed to understand the pervasiveness of our findings, allowed us to investigate what items people own and the role of generalized trust in their willingness to share those items. While lagging adoption and lack of critical mass are important factors in this explanation, our findings suggest that there are other barriers to adoption.

³<https://angel.co/peerby> accessed April 2016

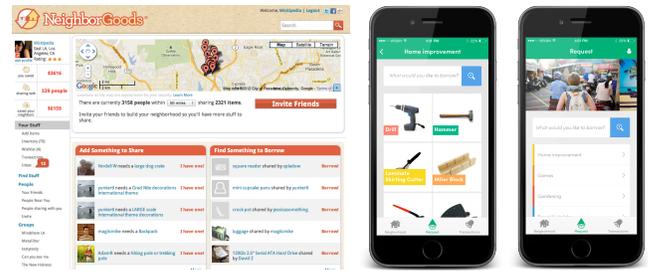


Figure 1. Screenshots of Neighborgoods (left) and Peerby app (right)

We offer TAMIES, an expansion to TAM for indirect exchange services, including the peer-to-peer resource sharing services that we explore in this work.

BACKGROUND

Relevant research has been conducted on other direct and indirect exchange systems, TAM and its applicability to different systems, and people’s attitudes and concerns towards sharing possessions. This body of work provided the foundation from which we studied the adoption of peer-to-peer resource sharing.

Participation in Peer-to-Peer Services

Previous research has shown that people are motivated to participate in direct exchange systems for a number of often contradictory reasons including sustainability, community and economic gain [1, 4, 11]. People who build or help operate peer-to-peer systems are motivated by community and sustainability, while users (including those who provide the services) are often more motivated by value and convenience [4]. Similarly, even though sustainability is an important factor for attitudes towards participating, economic benefits are stronger motivators for actual use [11].

Other complications often arise in exchange systems beyond those around motivation. Kassi was a primarily indirect exchange system where people were able to share physical goods, give or get help, or share rides with people. Researchers found that the lack of users and content, as well as the time investment required on the platform and for travel were negative aspects of Kassi [36] and these non-monetary exchanges led to feelings of indebtedness [18]. In a study of peer-to-peer exchange in a single parents’ network, Lampinen *et al.* [17] found that efforts to balance attracting a critical mass of users with the desire for trusted relationships between members caused difficulties for the network. A number of studies have shown that peer-exchange systems often struggle to attract the right kind of participation from members, which also affects levels of participation. For instance, sharing platforms can be subject to social hierarchies and other forms of exclusion [33], while one time bank lacked a supply of in-demand skilled-services because it struggled to motivate its professionally qualified members to offer their skills [33].

Another obstacle to adoption of a peer-to-peer system could be trust. Dillahunt & Malone showed that among residents of

disadvantaged communities, major trust and safety issues prevented people from using services like Neighborgoods, Lyft, Airbnb, and TaskRabbit [9]. Similarly, a study of TaskRabbit showed that residents of areas with low socioeconomic status would have to pay more in order to use the service because of the longer distance of travel and higher crime of the neighborhoods [37]. These studies surfaced the importance that trust and safety have in participation in predominantly direct exchange services, which we expected would play an equally, if not more, significant role in sharing exchanges void of monetary assurances. In both of these studies, residents were not concerned with being able to trust a particular individual, rather their results suggest that these people may have low trust overall. We sought to understand to what extent generalized trust might contribute to the adoption of peer-exchange systems [28].

Technology Acceptance Model

Understanding how to attract a critical mass of users to groupware and other interactive media systems (such as email, telephone or instant messaging) has long been acknowledged as a crucial problem [10], as users of these systems are necessarily dependent on one another for functionality. The widely-used Technology Acceptance Model (TAM) [8] includes perceived usefulness and perceived ease of use as the biggest predictors of behavioral intention, however Lou *et al* [22] extended it for groupware systems and found that perceived critical mass had the largest total effect on an individual's intention to use groupware, influencing both perceived ease of use and perceived usefulness as well as directly influencing behavioral intention. Similarly, Lou *et al* [21] found that perceived critical mass (along with perceived usefulness and perceived enjoyment) predicted behavioral intention to continue to use instant messaging. Peer-to-peer systems are similar in this regard, as users are also necessarily dependent on one another, making critical mass equally crucial.

Markus [24] argues that the reason interactive media systems are particularly vulnerable to start-up problems and discontinuance is because use entails *reciprocal interdependence*: early adopters are influenced by later adopters and non-adopters (as well as vice-versa). As a result, early adopters of these systems experience relatively low benefits and high costs, making discontinuance more likely. It is clear that peer-to-peer resource sharing services also entail reciprocal interdependence: the inventory of borrow-able items, and people to lend items to, will be influenced by later adopters and non-adopters alike.

However, another characteristic of interactive media systems that further influences acceptance is that some users will provide more benefits to the community through their contributions or use of the medium than they will receive from using it [24]. In the context of indirect exchange systems, asymmetric contributions could manifest as some users acting more as providers than as consumers in the system, as observed in other sharing economy systems such as time-banking [5]. As some users might act more as providers in the system, other motivational factors beyond perceived critical mass, perceived usefulness and perceived ease of use are likely to be at play in the acceptance of indirect exchange services.

Sharing of Physical Resources

Other barriers could also be present when sharing physical goods in particular. We examined literature on the social logic of sharing more broadly to better understand the nuances of how people negotiate relationships with physical objects.

People form strong attachments and associations with their possessions. They use them to define the self, connect with the past, and fulfill duty to others [15], which can restrict the people with whom they are willing to share them. Belk [2] argues that it is when the boundary between the self and other is removed that sharing can occur most easily. For instance, sharing is common within the family home: members of the family share food and common spaces and those who 'feel-at-home' do not feel the need to ask permission to do so. However, with the exception of the family, in the contemporary Western world, not-sharing is the norm [3].

When interpersonal borrowing and lending does occur, the relationship people have with their possessions can be complicated for a number of reasons. Temporary possession of someone else's object can lead to a necessary "re-sacralization" of a borrowed item: cleaning or mending it before returning it to its owner [13]. Further, attitudes towards the item can be influenced by the perceived qualities of the previous owner. Nemeroff and Rozin [7] found negative contagion effects involving wearing the sweater of another person, when the other person was seen as bad (e.g., fanatical leader or murderer) and positive contagion effects when the previous owner was seen as good (e.g., rock star, lover). Similarly, one of the motivations of re-acquisition, the process of obtaining an object that has been previously used by someone else, is that the aesthetic qualities of an object can be desirable *because* of its former use [30]. Sharing, therefore, is governed not just by factors of utility, but also the relationship between both the borrower and lender as well as between the lender and object.

Our study builds upon this previous work by examining the extent to which non-adoption of indirect exchange systems might be attributed to coordination difficulties, avoidance of indebtedness, inequalities, factors concerning the general lack of sharing among adults as identified by previous literature, or whether other factors related to the sharing of objects might be inhibiting adoption.

METHODS

To address the research questions above, we used a mixed methods approach. First, to understand attitudes towards peer-to-peer sharing and adoption challenges in these systems, we conducted semi-structured interviews with 37 residents of New York City, 9 of whom had previously used a peer-to-peer sharing site. To generalize our findings and more deeply understand the role of trust, we conducted an online survey with 195 respondents.

Interviews

In the first set of interviews, we spoke with 28 residents (55% female) of New York City to understand their attitudes towards and expected use of peer-to-peer sharing sites. We chose to focus on a large urban city because of the potential benefits of sharing in a dense environment and social barriers that may

exist in urban areas [34]. The participants were recruited via Craigslist and were required not to have used a peer-to-peer resource sharing service before. They ranged in age from 18 to 64 and had occupations such as student, housekeeper, actor, and therapist. 22% of the participants had previously borrowed or lent something to a neighbor and 25% had used one or more direct exchange services previously.

The interviews were divided into two parts. The first part gauged the participants' involvement in their community through questions about their perceptions of their neighborhood, their current lending and borrowing practices and their use of other peer-to-peer services like Uber and TaskRabbit. The second part of the interview involved engaging participants in hypothetical borrowing and lending situations. We described the concept of peer-to-peer resource sharing to the participants. We then asked participants what items they would or would not be willing to borrow and lend, how they would imagine coordinating an exchange, and how they would decide to whom to borrow or lend.

In a second set of interviews, we interviewed 9 people in New York City who had previously used either NeighborGoods or Peerby. Participants were recruited through posts on Peerby and NeighborGoods, advertising for interview participants. The first part of our interviews was the same as described above for the other set of interviews. During the second part, participants in this set of interviews were asked to recount in detail their successful and unsuccessful exchanges on Peerby or NeighborGoods.

Interviews were audio-recorded and transcribed verbatim. They ranged from 10 minutes to 45 minutes long (median length was 23 minutes). The transcripts were anonymized and imported into Dedoose where four independent coders read through and analyzed the interviews, with themes related to barriers to adoption of peer-to-peer resource sharing services serving to guide the analysis. At least two coders read through each interview. Following an open-coding process, two of the authors met several times to define, discuss, and reconcile the codes. Interviewees were compensated \$10 for participation. A preliminary analysis of these interviews was reported in [25].

Survey

We complemented our interview results with a survey, designed to investigate what goods people own and the role of generalized trust in their willingness to share those goods. The survey, deployed after the interviews were completed and coded, asked respondents about items that were discussed by interview participants. We asked respondents to indicate whether or not they owned 17 household objects. For objects they reported owning, we asked whether or not they would be willing to lend them to others (family, friend or neighbor) and for objects they reported not owned we asked whether they would be willing to borrow them from others (family, friend or neighbor). We also included a measure of generalized trust, and requested demographic information including the participant's residence zip code. We recruited survey participants from three separate online groups: two Facebook groups, Broke List and Buy Nothing BoCoCa (a cluster of

neighborhoods in Brooklyn), and a Google Group listserv for mothers in northern New Jersey. A link to the survey was posted as a Facebook Wall Post in the Broke List and Buy Nothing groups and was sent via email to the listserv group. We also posted the survey to Amazon Mechanical Turk, limiting the responses to those who live in New York State. We received 363 responses in total, 259 from MTurk and 90 from the online groups. The average age of MTurk respondents was 33.1, and the average age of a member of one of the online groups was 38.1. While 56.8% of the MTurk respondents were female, 92.7% of the online groups were female, a biased sample since one of the groups was exclusively for mothers.

We present the findings of the interviews and survey together, grouped by topic. Those who participated in the interviews are referred to generally as 'participants'. We distinguish between people who had used either NeighborGoods or Peerby and those who had not by referring to them as 'users' and 'residents' and labeling their quotes (to include demographic information) as 'R<id> (<gender><age range>)' and 'U<id> (<gender><age range>)', respectively. Those who responded to the survey are referred to collectively as 'respondents'.

FINDINGS

Our interviews uncovered a variety of reasons for using peer borrowing/lending platforms, as well as barriers preventing adoption. Participants listed potential benefits including cost efficiency, saving space, creating community, convenience, and not wasting resources. Besides practical utility, several residents, from our first set of interviews, spoke about borrowing and lending items as a means of helping or making connections with others. For instance, one user commented:

"It's something you can do to help somebody make a difference in their lives and it makes things easier. It also helps me get to know a person...That could be more important than borrowing. You're connecting people with one another." (U8 (M25-34))

Despite interest in using such a platform, we identified a set of concerns and exposed several challenges to adoption of peer lending and borrowing systems. We expand below on these issues, organized under three main themes: norms of sharing, potential risks, and issues of synchronization and coordination.

Norms

Although most of our participants had not participated in an exchange using a peer-to-peer resource sharing site, they nonetheless expressed clear views about expected norms. Participants had concerns about both lending their personal items as well as objects that did not align with their expectations of things that borrowers should ask to lend.

Personal Items

When asked what type of items they would not want to borrow or lend using a peer-to-peer service, 14 participants mentioned things that were considered too personal for a variety of reasons. These included items they considered unhygienic, similar to previous research on reacquisition [30], as well as items like electronics that contained their personal information.

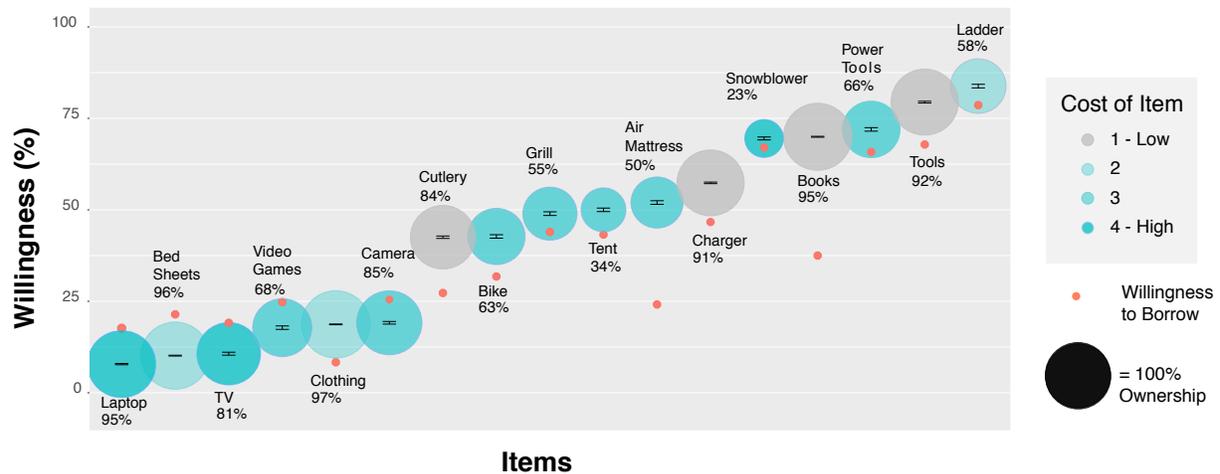


Figure 2. Willingness to Share Different Objects with Neighbors Based on Ownership of Items. Circle size is percentage of survey respondents who own that item. Position on the y-axis represents percentage who would be willing to lend it to a neighbor. Labels give the exact ownership percentage and color of the circles represents relative cost. Orange dots are percent of people who do not own the item who would be willing to borrow it from a neighbor.

While there was a range in what was considered unhygienic to share, many users expressed an unwillingness to share items that were commonly worn or used on the body. These included objects like comforters, towels, and clothing. As R27 (M18-24) explained, “I wouldn’t want to borrow someone else’s bed sheets even if they had washed them. To me, that’s too personal.” R12 (F35-44) revealed a practical reason for concern with sharing these types of items. “Nowadays with bed bugs going around, you can’t lend cloth or something like that.” One Peerby user verified that people were requesting items that could be susceptible to bed bugs. “[T]he one thing that I have seen people request that I would maybe not be comfortable with would be something like an air mattress, or some sort of bedding.” (U32 (F25-34))

People were concerned about lending people their electronics, including their laptops and cell phones.

“[P]eople might want to borrow something just because they might need to do something quickly, but that would be like handing somebody my wallet, you know? It’s just a little too personal.” (R14 (M55-65))

Value Judgments Towards Borrower

A theme that arose with eight of the participants was that lenders had expectations for borrowers beyond being able to trust them. People expected borrowers to have a reason for asking for their items that aligned with their opinions or uses of the objects. As R15 (M18-24) explained, “It goes back to you need this item for X and Y reason, and I think X and Y reason is valid, so sure, I’d be willing to lend it to you.” Other reasons that participants listed as valid were if people could not afford the items (R21 (F25-34)) or if there were an emergency situation (R4 (M18-24)). The borrower’s intended use would indicate to R37 (F25-34) to whom to lend an item. She stated that “one occasion might outweigh another ... maybe a kids’ party would outweigh just having a chair there for a family.”

Participants were hesitant to lend items that they felt people had access to elsewhere. R27 (M18-24) was unwilling to share his laptop with his neighbors justifying his reluctance by saying, “They could go to the library and use a computer... They have an alternative.” One Peerby user was unwilling to share her charger because she felt like it was something that other people should own. “It’s the sort of thing you really should have and also it’s relatively low-investment ... You’d probably use it over and over again.” (U34 (F25-34))

Judging a person who wants to borrow a charger is similar to the type of judgments towards other participants that Schor *et al.* [33] observed in a local food swap. The value judgments being made towards other members and their attempts to participate were detrimental to the network as a whole.

The survey generally confirmed the results from the interviews. Respondents were asked to indicate how willing or unwilling they would be to share items they own with someone in their neighborhood. Figure 2 shows people’s willingness to share the objects they own. The size of the circles represents the percentage of respondents who said that they owned that item and the position on the y-axis represents the percentage of people who said they would be willing to lend that item to a neighbor. Items are ordered by willingness and the labels give the exact ownership percentage. The color of the circles represents a typical relative cost of the items. The orange dots show the percentage of respondents who do not own the item who would be willing to borrow it from a neighbor. For example, 50% of respondents owned an air mattress (the size of the circle), an item that is somewhat high in cost (the color of the circle). Of those that own an air mattress, 52% are willing to lend it to a neighbor (position of the circle on the y-axis) whereas only 24% of those that do not own an air mattress would be willing to borrow it from a neighbor (position of the orange dot on the y-axis).

Confirming the results from our interviews, respondents were unwilling to borrow or lend personal items such as bedding, laptops, and clothing. Respondents reported being most willing to share items that were smaller and cheaper, like books and tools. Chargers also rated high on willingness, which was contrary to the statement from the participant above. In general, people showed a similarity in the types of things they would be willing to borrow and lend, with the exception of books and air mattresses. Given the high ownership of books (95%), the difference observed could be due to the low sample size of respondents presented with the willingness to borrow question. The air mattress had a more even distribution between borrowing and lending since ownership was 50%. According to Horton and Zeckhauser [12], items that are used both predictably and infrequently, for large chunks of time are those that are best suited for sharing. For instance, a tuxedo is more suitable for sharing than a blender because use of a tuxedo is predictable, infrequent for longer periods of time. Whereas a blender is used more unpredictably and for shorter periods of time, increasing the transaction costs associated with borrowing or lending the item. An air mattress is used infrequently and predictably, for large chunks of time (e.g. when someone comes to visit), making it easier for borrowers and lenders to plan their use of the item. However, the item was rated higher on willingness to lend than willingness to borrow. If the concern is with bed bugs, as mentioned by several interview participants, the difference in willingness could be due to the fact that borrowers are wary of whether or not the lender has bed bugs. This could be less of a concern for a lender since a borrower would only have temporary possession of the item.

Risks

Interview participants expressed concern over risks both to themselves and to the items being lent. They had difficulty with the idea of trusting someone through a website without other forms of verification or authentication. These concerns were exacerbated for more expensive objects where damages could be hefty.

Safety

Mixed attitudes were present when people were discussing others with whom they would potentially interact. For instance, many were wary about interacting with strangers and R13 (F35-44) was uninterested in using the site because of safety concerns about interacting with strangers. *"I still would wonder about the safety...and not knowing the person, so I think I'd probably wouldn't do that right now."* Familiarity with the other person was important to the participants' decision who to borrow or lend from. *"I'd rather borrow from somebody I know rather than somebody I don't know, because sometimes strangers are really creepy"* (R27 (M18-24)).

However, even when neighbors were known, attitudes towards their trustworthiness differed. Those with positive, trusting relationships with their neighbors, like R28 (M25-34), expressed more willingness to use the system. *"I would lend [musical equipment] to a neighbor. I'm kind of close with my neighbors...I would trust them to return everything in the way that it was given."* R23 (F45-54) explained that she would trust her

neighbors because of their social connections to one another. *"...Within a mile away somebody always knows somebody who knows somebody, who knows somebody...There's an implied trust with distance."* Though, for some, the neighborhood was actually a signifier for a lack of trust; *"maybe because I live in Brooklyn. I think it would be a different story somewhere else. There's not that much trust."* (R12 (F35-44)). Many of the participants (8/28) mentioned a desire for some kind of validation that the borrower was who he/she claimed to be and would not abuse their possessions.

However, in general, Peerby and NeighborGoods do not offer much to verify the identity of users or provide assistance in creating safe exchanges. Reviews or other forms of verification were suggested ways of easing users' concerns. *"You feel more comfortable knowing that this person has good reviews."* (R19 (M25-34)). While this was clearly a concern for some participants, others recognized that not everyone necessarily needed to be concerned. R3 (M45-54) was one of these exceptions. *"I'm a 6 foot tall athletic white man. I feel like I don't have a lot, at least compared to maybe other people, I don't have a ton to be afraid of."*

There was a sense that the mode of communication could either be a barrier or an aid to forming trust. For four of the participants the communication process was seen as a vital part in establishing whether or not to trust the other person by *"feeling them out"* (R23 (F45-54)). R25 (F18-24) explained, *"I would want to get a feel for the person, whether I can trust them. Then I will decide from there."* For R30 (M25-34), the mode of communication changed how much information about the other person they could glean. *"I don't prefer text messages, no, because I don't know if that person, until they then call me, actually speaking on the phone, I just don't trust them."*

Five participants expressed fears about meeting the person in real life, which often manifested in people not wanting to reveal the location of their home to others, either by meeting at a public place or a location adjacent to their homes. R4 (M18-24) wanted to meet at *"Any big places, like stores... like a drop location, where they could meet up."* These quotes echo findings of Dillahunt & Malone [9], who found that safe meeting places were also desired for peer-to-peer exchange services. R28 (M25-34) who also uses Craigslist for selling goods, circumvents this possibility by choosing a location *"a block or two away from my house. So, people don't know exactly where you live."*

To understand how the tendency towards lending is related to trust, our survey also included a well-established measure of generalized trust on an 11-point Likert Scale [23]; *"Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?"* (1 = Can't be too careful, 11 = Most people can be trusted). We excluded respondents who had responded with 1 to the trust measure to ensure a normal distribution of responses (including those respondents did not significantly alter the results). 316 responses remained after the exclusion. For each respondent, we calculated a "Willingness to Lend" Score, a sum of the total number of different items that a person

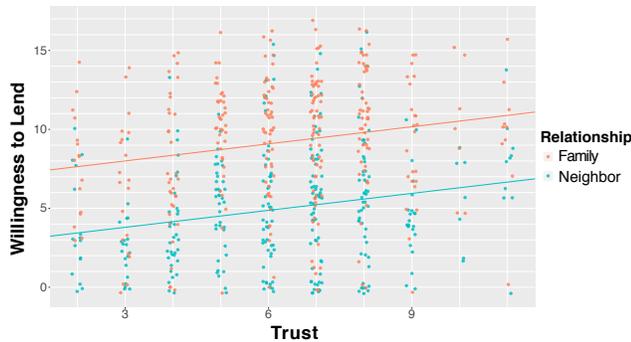


Figure 3. Influence of Trust on Willingness to Lend by Relationship to Borrower. Linear regression showed Trust had a significant effect on Willingness to Lend for neighbors ($t = 3.789, p < 0.001$) and a significant effect for family ($t = 3.466, p < 0.001$). Willingness to Lend starts at a higher level for family than for neighbors.

indicated they would be willing to share with a neighbor or family. Using responses to the general trust question, we estimated a linear regression model predicting Willingness to Lend Score from Trust. Each individual respondent is represented by two points in the graph, one orange and one green. Our model showed that Trust had a significant effect on Willingness to Lend for neighbors ($t = 3.789, p < 0.001$) and a significant effect for family ($t = 3.466, p < 0.001$). Figure 3 shows the model for Willingness to Lend against Trust for neighbors and family. Intercepts of 6.91 for family and 2.72 for neighbors suggest that Willingness to Lend starts at a higher level for family than for neighbors. While willingness to lend more items increases as trust increases, the difference in slopes shows that trust, as expected, has a stronger influence on people's willingness to share items with neighbors than with family.

Financial Considerations

Many participants were interested in borrowing expensive goods, particularly to be able to use them without having to spend significant amounts of money. For instance, residents discussed the desire to borrow items like a "top of the line camera" (R1 (M35-44)) or a flat screen TV. However, unsurprisingly, people were concerned about lending expensive items. Fifteen residents were worried about their goods being damaged or potential warranty implications and expressed a desire to have some security or liability for damages. For instance, one resident said:

"What if they crack [the vacuum cleaner]? Let's say you're calling Dyson. You're like, 'Hey I lent it to my neighbor and my neighbor broke it,' Do you really think Dyson's going to mail you a new part for free? No...It could damage the warranty." (R12 (F35-44))

Suggestions to overcome these concerns came in the form having the lender pay to cover the cost of damages, a contract, or some way of ensuring that people's items would be returned in the same condition they were lent. However, residents recognized the tension between the cost of financial or contractual

assurances and keeping the service free. *"I think it would be best if it was free, however with the condition stuff, you might need to leave a deposit just to make sure it's not damaged." (R17 (M25-34))*

As a result, some residents would only be willing to lend out cheaper items, where damages would be less consequential. R26 (M25-34) stated *"If somebody asked me for a hammer or a screwdriver I would [lend it], because the price point is low. I wouldn't give them anything expensive."*

While people often expressed a desire to borrow expensive items, nine out of 28 were concerned about being potentially responsible for damaging someone else's goods.

"I wouldn't want to be in a place where I'm borrowing something really expensive...I don't necessarily know [my neighbors] that well...I'd need to be extra careful...and that kind of limits what I feel comfortable doing." (R15 (M18-24))

User of NeighborGoods and Peerby showed similar concerns to other users about liability for damages. Four out of nine users shared concerns about having their items being damaged by a borrower and without any assurances about their items, they simply choose not to share valuable things: *"Yes, I wouldn't lend out my laptop or my camera, because those things...those are too valuable for me." (U31 (M25-34))"*

Echoing the sentiment expressed by people who had not previously used Peerby and NeighborGoods, those who had were concerned about lending and borrowing expensive items. U34 (F25-34) stated that she would be willing to borrow something *"...like a stud finder, it's basically impossible to ruin a stud finder,"* while U24 (F25-34) stated that *"I think it was just a toolkit, because I figured there's no way I could ruin that."*

Survey respondents were prompted to indicate which items they owned from a list and to indicate their willingness to share those items with a neighbor, as shown in Figure 2. Respondents agreed with the interview participants by being generally more willing to share less expensive items, such as Tools, Ladders, Books and Chargers (gray shaded in Figure 2) and less willing to share expensive items like Laptops, TVs and Cameras (green shaded, appearing mostly on the bottom left of Figure 2).

The high willingness to lend score for an expensive item such as a snow blower could be explained by the usage patterns associated with it. A snow blower is used both infrequently and somewhat predictably, making it a good candidate for sharing [12]. However, a tent, which is also used infrequently and predictably, scored considerably lower on the willingness scale than might be expected if frequency and predictability of use were the only factors. In [12], it is assumed that borrowers will pay lenders for use of their items. It is possible that, for specialist and easily damaged equipment like tents, the motivation for sharing becomes higher when there is a financial incentive associated with it, while in a free model, the potential cost of damages outweighs frequency and predictability of use. While damage to a snow blower is certainly possible, use does not involve taking the item away from home or require

knowledge to correctly assembling the item with small parts that can easily be damaged or lost, as is the case with a tent.

Coordination

Even for those participants who were interested in using this kind of platform, another issue arose in the objects that would be available. Participants wanted to borrow items that they would use infrequently, were large in size, and seasonally appropriate, but not as many people owned these items.

Frequency of Use

Objects that were used more frequently were seen to be too much of a hassle for coordination. R22 (F25-34) explained the importance of frequency of use, *“Let’s say if it was GoPro camera, I would want to buy that on my own. I wouldn’t want to keep borrowing. If it was some type of tools or something that I’m not really interested in, but I need it at the time, I would want to borrow that.”*

Users of the sites shared similar sentiments about frequency of use. For instance, one user of NeighborGoods spoke about weighing frequency of use and the coordination involved with borrowing with the cost of buying an item to decide whether or not to borrow from the site:

“[If] I’m only going to use once...I’ll go to NeighborGoods. If there’s something I know that I really need on a regular basis and it’s going to be a pain in the butt to share that all the time with someone, then I’ll buy one for my own for cheap.” (U5 (F25-34))

One NeighborGoods user confirmed that frequency of use and cost are the main factors to consider in terms of borrowing an item from a site like this *“I can see people wanting to borrow a nail gun or staple gun...it’s not really something you buy just to use once. That’s exactly the sort of market I envisioned that Peerby was invented for.” (U34 (FF25-34))*

Size Matters

Common among residents was the idea that borrowing larger items would be beneficial so that they would not have to store them in their own apartments. In dense urban areas like New York City, where people do not have an excess of storage space, this is of particular concern. One resident commented,

“[If] you live in an apartment... all this stuff just isn’t practical to have, it’s just too big. I don’t know, a carpet deep cleaner or something...if you could borrow it that would be great because it does come in handy once in a while.” (R16 (F18-24))

However, there were some concerns that the practicalities of moving larger items would make borrowing them difficult. For instance, R25 (F18-24) expressed concern about moving tables *“Say you’re having a barbecue, and you need to borrow a bunch of tables. It might be a hassle to move it and get it back.”*

Users of NeighborGoods and Peerby had similar concerns about size. For instance, U34 (F25-34) shared sentiments about people who live in the city often lacking storage space. *“Yeah, things like a ladder, or maybe some camping equipment.*

Just things that I think in New York City... If you don’t have storage space, a lot of people just don’t keep around.”

If everyone is trying to minimize the amount of stuff they own due to a lack of storage space it is not clear who, in a dense urban environment, will have the storage space for items that can be loaned out. This contradiction was summed up in the way U34 (F25-34) spoke about ladders, *“Nobody wants a ladder clogging up their house...That ladder I feel is the perfect example of things you would borrow with a service like this.”*

Seasonality

Another problem that arose during 8 of our interviews was that people’s needs for certain items would converge at the same time. This was true of items that were seasonal, or had heavy use during certain parts of the year like camping equipment.

Snow blowers came up multiple times during our interviews as objects that people often need or would find useful to borrow. However, because everyone, including the owner of the item, would want to use it at the same time, maintaining the supply to meet the demand of borrowers would be difficult for seasonal goods. R12 (F35-44) described such a scenario,

“I could just see it’s snowing, and five million people are looking for a snow blower, and then there’s one person with a snow blower willing to lend it out. I could just see it being a mess with something like that.”

Users of Peerby and NeighborGoods confirmed the importance of seasonal goods. With tools as the exception, they often articulated their requests for objects in terms of seasonal events. For example, U36 (F25-34) was unable to borrow a seasonal item through the sharing platform.

“We were thinking about going on some sort of camping trip and it would have been really nice to borrow a tent, but we had to borrow it from someone else because that didn’t come through [on the site].”

This example of failed use highlights an instance when a user wanted to borrow from the site but was unable to due to the lack of supply.

The results from our survey verified that ownership of seasonal goods is the lowest compared to other household goods. As compared to the most commonly reported category of ownership of Clothing (97%), Bed Sheets (96%), Laptop (95%) and Books (95%), seasonal items had the lowest ownership, like Snow blower (23%), and Tent (34%).

DISCUSSION: TAMIES

Based on our findings, we propose a potential adoption model for indirect exchange services (See Figure 4) built upon Lou *et al’s* [22] original Groupware model (shown in gray), and incorporating other recent work on peer-to-peer services. While the research was done in the context of a specific type of service – peer-to-peer resource sharing – we believe (as noted above) that the model generally applies to other indirect exchange systems, e.g. CouchSurfing and Freecycle, or systems for time banking [4].

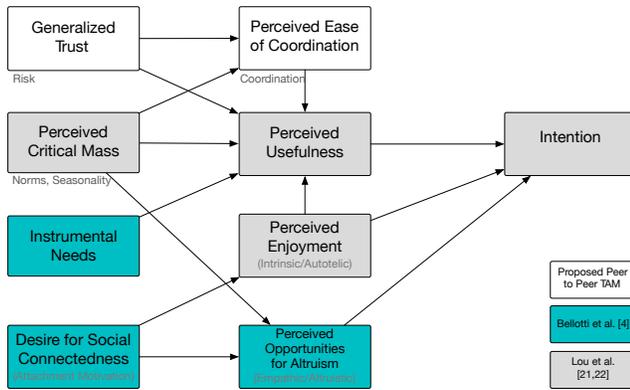


Figure 4. Proposed TAM for Indirect Exchange Systems (TAMIES)

The Technology Acceptance Model for Indirect Exchange Systems (TAMIES) aims to capture both the individual characteristics of a particular user as well as their perception of the service as predictors of behavioral intention. New additions to the model include Instrumental Needs, Desire for Social Connectedness, and Perceived Opportunity for Altruism since Bellotti *et al* [4] found these to be strong motivations for participation in peer-to-peer exchange systems. Following, we introduce Generalized Trust and Ease of Coordination as new factors in the model and explain how Critical Mass, Opportunity for Altruism, and Usefulness may differ for a peer-to-peer resource sharing system and indirect exchange systems in general.

Generalized Trust

Trust is an important attribute in adopting a peer to peer system, but establishing trust is complicated. As detailed in the Risks section of the Findings, our results show that generalized trust may play a significant role in whether or not people would lend items. Our interview findings suggested that people may be more willing to share if there were monetary or assurance structures [16] in place to support the exchanges. However, monetary structures could fundamentally change the system from an indirect to a direct exchange service and potentially eliminate belief in the commons [6].

Without the need for financial assurances, Lampinen and Cheshire [16] suggest that key uncertainty-reducing mechanism in binding interactions is the establishment of a trusted third party to ensure an agreement and that these third parties might also facilitate exchanges of good, services or favors more directly. In this context, the establishment of a safe sharing space for exchanges to happen, or logging or tracking mechanisms to ensure the safety and timely return of people's good might also serve as a key assurance mechanism to encourage new producers into participation. However, even non-monetary assurance structures can affect the ties that form between users in a peer to peer system. Parigi and State showed that the online rating system in Couchsurfing supplanted the need for interpersonal trust, but at the cost of decreasing the deep ties that formed [29].

Ease of Coordination

We replaced the perceived ease of use category from the original TAM with perceived ease of coordination. While ease of use reflects ease in an interaction design sense, we aim to capture interaction beyond that of just the user interface. This change reflects the concerns our interviewees had regarding finding and transporting items when borrowing and lending, including size and seasonal concerns as detailed in the Coordination section of the Findings. This was also an issue that was also reported in previous research on Kassi [36]. Perceived ease of coordination aims to capture the ease with which a user can find and request an item to borrow (which necessarily includes the ease of use of the system's interface), while also including the ease with which a user can coordinate with another member of the network to set up a successful exchange.

Perceived Opportunity for Altruism

Another addition to previous TAMs is perceived opportunity for altruism, the extent to which a user feels like they are helping out someone else by using the system. Helping others was brought up several times in interviews, though the influence of this attribute on adoption may differ depending on one's role in the system. Many indirect exchange services attempt to foster a purely altruistic and community ethos without providing strong instrumental motivations for all participants. Borrowers could benefit from access to physical goods at no cost, though lenders have no incentive to offer those goods beyond altruistic motivations. This discrepancy in motivations between providers and receivers in sharing systems was reported by Bellotti *et al.*, though they found that providers were much more motivated by altruism than receivers (51% and 6%, respectively) [4]. However, Schor *et al.* [33] found that it was difficult to construct transactional networks that were both egalitarian and robust. In their studies of a time bank and food swap, where the organizations remained truest to their sharing ethos of equality and access, they found that both struggled to maintain themselves due to a low volume of trades. While a makerspace and open education group both sustained robust participation, they were in some way exclusionary or required participants to adhere to a common culture and philosophy. Taken together, these results show that perceived opportunity for altruism is an important motivational factor, though might not be sufficient to attract enough members to create a robust transactional network for an indirect exchange service.

Perceived Critical Mass

In peer to peer systems, critical mass represents not only that a minimum number of people have joined the system but that there is also a minimum amount of goods being offered on the system in order for it to be adopted.

Critical Mass of Users

Lack of critical mass is a particular problem for systems in which users are interdependent [24], which often manifests for early adopters of these systems as low benefits and high costs relative to those obtainable, making discontinuance more likely. We can see from our findings that early adopters of Peerby and NeighborGoods are significantly affected by non-adopters. In the Norms section of the Findings, we described

how participants needed to perceive that people were sharing the right things in the right way in order to want to participate in the service. Users also struggled to create a robust transactional network due to a lack of opportunities for sharing: they complained about the lack of inventory available to borrow, the effort involved in traveling to borrow an item when the only available item is far away and the frustration experienced when there was no interest in the items they offered to lend. Furthermore, we can see how early adopters of these systems would be influenced by later users; as usage of the system grows, the opportunities for sharing expand for new and old users alike. When these issues are present, Markus [24] argues, the result will either be that use spreads to all members of a community or no one will use the medium because no one started using it or because usage fell off in the absence of reciprocity.

Critical Mass of Goods

Even if a critical mass of users is achieved, the Seasonality section of the Findings describes a number of mismatches in the attributes of the objects that people wanted to borrow and those that they were willing to lend that might present more systemic problems. Seasonal issues indicate that when a good is at its highest demand, it's less likely to be available, as the person who owns it will also need it during peak time. Direct exchange systems address this by paying the provider more in this situation (e.g. peak prices for hotel rooms and train tickets), and services like Uber provide surge pricing to attract providers during busy spells, but an indirect exchange system does not have the option to encourage providers in this way.

Asymmetric contributions were also seen as problematic for peer-to-peer file sharing systems where free riding, i.e. users who download but would not contribute content, was common. To compensate for the incongruity in the system, BitTorrent enforced a tit-for-tat strategy where a user had to upload a part of a file in order to download one from another user [31], which lead to increased cooperation. While the problems affecting peer-to-peer file sharing and peer-to-peer resource sharing are similar, the incentives for peer-to-peer resource sharing are likely to be different. Unlike with BitTorrent, where tit-for-tat was imposed between users who were trying to download the same file (and thus both had something to give), we cannot necessarily assume that any particular pair of individuals will be able to provide items for each other. It is also possible that asymmetric contributions are not unusual or entirely detrimental for networks of indirect exchange. Indeed, asymmetric contributions have been reported on other indirect exchange systems such as CouchSurfing [19], where there are users who host but never personally 'surf' and vice-versa. Our proposed model does not assume that a user needs to participate fully as both a producer and consumer, thus leaving open the possibility of asymmetric contribution.

Our results also showed that people tend to own items in similar categories, which might make it problematic to construct a useful and diverse pool of available items. Schor [32] argues that the proliferation of unwanted items that led to the rise of markets for recirculating goods (like Craigslist and eBay) was fueled partly by nearly two decades of heavy acquisition

of cheap imports. While, in the case of peer-to-peer resource sharing, this could guarantee a steady supply of these items on the site, it might only serve a relatively small market, since people tend to already own the kind of things that people are willing to lend (such as tools and books, see Figure 2).

Perceived Usefulness

While the original definition of perceived usefulness centered around job performance enhancement, usefulness for an indirect exchange system would involve gaining utility from the objects or service borrowed. Perceived critical mass directly affects the usefulness of a peer to peer system since a borrower's usage is dependent upon the resources available. The exact qualities of perceived usefulness differ depending on the service, but it is a factor that affects adoption regardless of the system. For a Couchsurfer, perceived usefulness would be a person's gain from staying with a host; for Freecycle, perceived usefulness would be the utility from a used object. For peer-to-peer resource sharing, our results indicated that items like ladders, power tools, and grills, had high potential for being shared in the system. These items were owned by around 25-50% of our respondents and over half of them said they would be willing to lend this item to a neighbor. This suggests that borrowing and lending these kinds of items could attract enough borrowers and lenders with enough item availability to sustain a robust trading network. However, without attracting a significant proportion of those lenders to the network, it becomes less likely that there will be items available to exchange. Research on other indirect exchange systems have shown that they can also suffer from similar discrepancies in potential usefulness and available supply in the network [33].

CONCLUSION AND FUTURE WORK

In this paper we show that current peer-to-peer resource sharing services do not provide sufficient motivations or assurance structures to encourage a critical mass of borrowers and lenders to participate. The services we studied, Peerby and NeighborGoods, rely heavily on encouraging participation through altruistic motivations that, while important, are not enough to get people to use the service. In addition, we found that even with a critical mass of users, there are items which risk being either too abundant (such as tool or books) or in too short supply (such as seasonal goods) that might make it more difficult to create a robust trading network. We propose TAMIES, an adoption model for peer-to-peer resource sharing services, that applies more generally to systems of indirect exchange. The model aims to capture the unique motivations involved in choosing to participate in such networks. Future work will aim to validate our proposed model.

We should note that there are several limitations of our study. Our interviewees and most survey participants were recruited from the New York City metropolitan area, a relatively affluent population. While participants were from a diverse set of backgrounds, they still represent a user base with a Western-culture bias, e.g. towards the concept of sharing. Future work should explore the attitudes towards sharing in other cultures and how that might affect adoption of indirect exchange services.

Finally, our findings suggest that there are trade-offs in finding a concrete value-proposition for ‘usefulness’ for lenders, as certain benefits for lenders can run contrary to usefulness for borrowers. Future work will explore additional motivations for lending. One potential solution would be providing storage space in which lenders could store items that they struggle to find space for in their own apartments if they agree to allow others to borrow items that are kept there. Another alternative could be to explore shared ownership schemes, which would collapse the distinction between borrower and lender and remove the need to balance contradictory motivations. This reshapes the problem as coordination (facilitating shared purchases between neighbors) and cooperation (facilitating storage and managing shared use) rather than trust and assurances.

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