

# Publication VI

Tang, T. and Hämäläinen, M.. Comparison of two local social media services in Finland and China by social network analysis. *International Journal of Social Network Mining*, VOL. 1, NO. 2, pages 209 – 224, December 2012.

© 2012 InderScience Publishers.

Reprinted with permission.



---

## **Comparison of two local social media services in Finland and China by social network analysis**

---

Tingan Tang\* and Matti Hämäläinen

Department of Computer Science and Engineering,  
Aalto University School of Science,  
Konemiehentie 2, 02150, Espoo, Finland  
E-mail: [tingan.tang@aalto.fi](mailto:tingan.tang@aalto.fi)  
E-mail: [matti.hamalainen@aalto.fi](mailto:matti.hamalainen@aalto.fi)

\*Corresponding author

**Abstract:** Social network analysis has been widely used in characterising user behaviours, social relationships, network evolution and service adoption of social media. However, previous research mostly focused on the famous global large scale social media such as Facebook, Wikipedia and Twitter. Comparatively, little research has been done for local social media. In this paper, we compare two similar campus-based social media for exchanging goods and services by social network analysis. We also explore the correlation between different social relationships (e.g., the friend relation and exchanging relation) and different user behaviours (e.g., the requesting and offering) by quadratic assignment procedure (QAP) and Pearson correlation analysis methods. Finally, we discuss our findings and future work.

**Keywords:** social media; social network analysis; online community; social exchange.

**Reference** to this paper should be made as follows: Tang, T. and Hämäläinen, M. (2012) 'Comparison of two local social media services in Finland and China by social network analysis', *Int. J. Social Network Mining*, Vol. 1, No. 2, pp.209–224.

**Biographical notes:** Tingan Tang holds an MSc in Engineering from the Guangdong University of Technology, China. He is Researcher and PhD candidate in the Software Business and Engineering Institute at the Aalto University School of Science, Finland.

Matti Hämäläinen holds a PhD from the Department of Management Science and Information Systems, University of Texas at Austin. He is a Professor in the Software Business and Engineering Institute at the Aalto University School of Science, Finland.

---

### **1 Introduction**

Nowadays, people are increasingly connected by different kinds of social media such as Facebook, Wikipedia, Youtube and Twitter, to name a few. Social media are media for social interaction through web and mobile technologies to share user-generated content

such as information, knowledge and opinions in the forms of words, pictures, audios and videos (Safko and Brake, 2009).

Social network analysis (SNA) has been widely used in studying user behaviours, social relationships, network evolution and service adoption of social media. For example, Singla and Richardson (2008) study the correlation between social networks and personal behaviour in MSN messenger network. Benevenuto et al. (2009) compare user interaction behaviour in Orkut, MySpace, Hi5 and LinkedIn. Viswanath et al. (2009) study the evolution of user interaction in Facebook. Java et al. (2007) study the user behaviour and service adoption situation in Twitter.

Although there are already numerous SNA research in social media area, previous research mostly focuses on the global large scale social media such as Facebook, Wikipedia, Youtube and Twitter (Singla and Richardson, 2008; Benevenuto et al., 2009; Viswanath et al., 2009; Maia et al., 2008; Brandes et al., 2009). Comparatively, little research has been done in local social media domain. To fill this gap and contribute to the body of knowledge in SNA in local social media, this paper compare the user behaviours and correlations between different social relationships and user behaviours of two similar campus-based social media for exchanging goods and services in Finland and China by SNA and correlation analysis.

### *1.1 Research questions*

The two local social media services under study in this paper are branched from the same code-base and deployed in a Finnish university and a Chinese university. We are particularly interested in the following two research questions:

- 1 What are the user behaviours and their similarities and differences in the two social media services?
- 2 What are the correlations between different social relationships and different user behaviours?

### *1.2 Research methodologies*

In order to answer the first research question, we use SNA to analyse different user behaviours such as exchanging and friending. The SNA data come from the two social media database records, which include different social network relationships such as friendships, groups and conversations. The main SNA tool is condor (Gloor and Zhao, 2004). The reason for choosing condor is that it is good at analysing the dynamics of social network evolution and quickly generating a snapshot of social network visualisation. We first export the database datasets and transform the data formats to the formats supported by condor. Then we analyse the data. Besides condor, internet community text analyser (ICTA) (Haythornthwaite and Gruzd, 2007; Gruzd and Haythornthwaite, 2008) was used for social media topics categorisation to understand the service usages. For the second research question, quadratic assignment procedure (QAP) correlation analysis by UCINET 6 (Borgatti et al., 2002) and Pearson correlation analysis by SAS were used to understand the correlations between different social relationships (e.g., the friend relation and exchanging relation) and different user behaviours (e.g., the requesting and offering behaviours) respectively.

### 1.3 Structure of the paper

The remainder of the paper is structured as follows: Section 2 briefly introduces the two studied campus-based social media services; Section 3 introduces the SNA theory. The results are presented in Section 4; We discuss the results and our future work in Section 5; Finally, Section 6 conclude the paper.

## 2 Campus-based social media

The background of the two campus-based social media originates from a social media research project ‘OtaSizzle’ in Finland Aalto University. OtaSizzle focuses on social media services especially the mobile ones and their creation, usage, research and innovation (Mäntylä et al., 2009).

### 2.1 Kassi in Finland

Up to now, five social media services have been created in OtaSizzle project (<http://sizl.org/>). Among these services, one of the most successful social media services is Kassi (<http://aalto.kassi.eu/en>), which is a social media platform for facilitating students and staff in Aalto campus to exchange goods and services. Kassi has been developed since the summer of 2008 and was publicly released in the fall of 2009. The registered users are more than 2,500 in the September of 2010. The core service of Kassi is exchanging goods and services (requesting something and offering something). Besides the core service, Kassi also provides social networking functionalities such as user profiles, friends and groups. The source code of Kassi and other OtaSizzle services is hosted in Github (<https://github.com/sizzlelab>).

**Figure 1** Kassi user interface (see online version for colours)

The screenshot displays the Kassi user interface. At the top, there is a search bar with the text "Etsi Kassiasta" and a search icon. To the right of the search bar are "Login" and "Create Account" buttons. Below the search bar is a navigation menu with "Home", "Requests", "Deals", and "About This bag" options. The main content area is divided into two columns. The left column is titled "Latest Open Requests" and contains three items: "Vacuum Flask / Thermos bottle" (purchased), "Grater / Grate" (purchased), and "Capacitor replacement screen" (purchased). The right column is titled "Newest open Deals" and contains three items: "Nokia Smartphones C7 + siliconkotelo" (sold), "Nokia N97 mobile phone" (sold), and "Red IKEA sofa" (given). Each item includes a small image, a status label, a description, and a timestamp. A "News" sidebar is visible on the right side of the page.

## 2.2 YOU in China

During the international collaboration of OtaSizzle project, OtaSizzle core services and end user services have been partly replicated and adapted in Nairobi University in Africa, Beijing University of Posts and Telecommunications (BUPT) in China and Berkeley University in USA (Tang et al., 2010). Among these expansions, Kassi service has been adapted and deployed in BUPT with a new name 'YOU' (<http://you.mobroad.com/>). In August of 2010, the localised YOU service (e.g., Chinese translation and user interface changes) was finished. In January of 2011, the registered users in YOU is a little more than 1,000.

**Figure 2** YOU user interface (see online version for colours)



## 3 SNA theory

In order to better understand the interpretation of the SNA results in the paper, it is helpful to brush up a little about SNA theory. SNA studies the social relationships (ties) such as friendships and communications among social actors such as individuals or organisations (nodes) and the patterns and implications of these relationships (Wasserman and Faust, 1995). The three most popular individual or actor centralities to measure the relative importance of an actor in a network are as follows (Wasserman and Faust, 1995):

- *Degree centrality*: Degree centrality is the number of ties a node has. For example, in a undirected friendship network, the friendship degree of an individual is the total number of friends he or she has. For directed networks, degree centrality divides into in-degree (the number of ties connected to a node) and out-degree (the number of ties connected from a node). For example, in a personal e-mail communication

network, the in-degree is the number of e-mails received and the out-degree is the number of e-mails sent.

- *Betweenness centrality*: Betweenness centrality measures the importance of a node as a ‘bridge’ or ‘middleman’ role in a network.
- *Closeness centrality*: Closeness centrality measures the closeness by geodesic distances of a node to other nodes in a network.

Except the aforementioned three node or actor centralities, these are also corresponding network or group degree, betweenness and closeness centralities. From Freeman’s group centrality computation formula (Wasserman and Faust, 1995), we know that the group centrality equals to 0 when all actors have exactly the same centrality index (degree, betweenness or closeness centrality), and equals to 1 if one actor, ‘completely dominate or overshadow’ the other actors (the star shape of network structure). In other words, if group centralities decrease, the group members’ positions or behaviours become more similar or ‘democratic’ in the network. On the contrary, if the group centralities increase, this means that group members behaviours become more differentiated or ‘hierarchical’ as few core or leader players dominate the network.

## 4 Results

### 4.1 Exchanging behaviour

As we mentioned in the Section 2, the core function of Kassi and YOU is to help students exchange goods (e.g., second-handed books and furnitures) and services (e.g., ride sharing and housing sharing). Kassi dataset is from September 2009 to September 2010 (one year), while YOU dataset is from August 2010 to January 2011 (half year). Table 1 shows the statistics of goods and services usages in Kassi and YOU.

**Table 1** Statistics of goods and services in Kassi and YOU

	<i>Kassi</i>	<i>YOU</i>
Goods offers	802	704
Goods requests	261	103
Services offers	221	76
Services requests	119	8
Total	1,403	891

Although the time spans of data records for Kassi and YOU are different, we can still see some usages patterns from Table 1. For similarities, both Kassi and YOU have far more goods than services. Both Kassi and YOU have far more offers than requests. For differences, the ratio between services and goods in Kassi is much higher than that in YOU. The ratio between requests and offers in Kassi is also much higher than that in YOU.

Figures 3 and 4 show the top 30 terms discussed in Kassi and YOU by ICTA text analyser. From Figures 3 and 4, we can also see that both Kassi and YOU terms are closely related with students’ campus lives such as studying, living and entertainment. However, we can also see the differences. For example, the top 2 terms in Kassi is

‘asking price’ and ‘apartments’, while in YOU they are ‘information’ and ‘book’. This might related with culture and context differences.

**Figure 3** Top 30 terms in Kassi (see online version for colours)

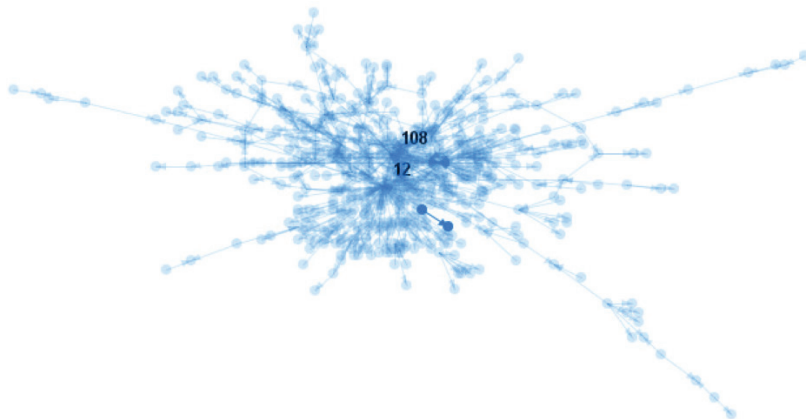


**Figure 4** Top 30 terms in YOU (see online version for colours)

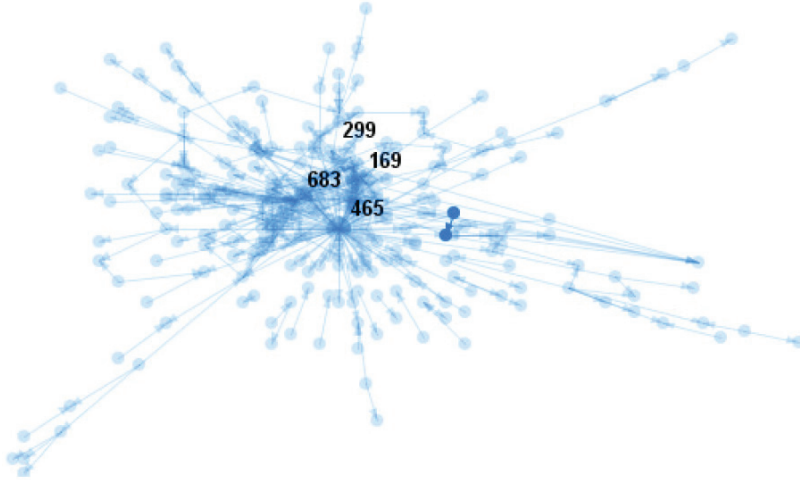


Although the above statistics numbers and text analysis give an overview of two social media service usage scenarios, they do not provide the dynamics of user exchanging behaviour over time. In order to understand the evolution of exchanging behaviour, we use Condor to analyse the exchanging communication or conversation data. Conversation network is a directed network.

**Figure 5** Kassi conversation network (see online version for colours)



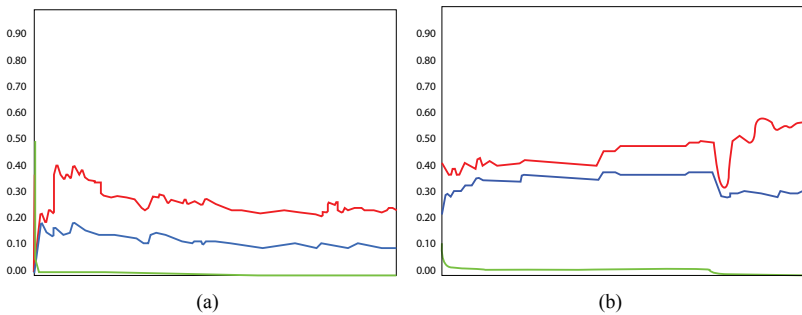
**Figure 6** YOU conversation network (see online version for colours)



Figures 5 and 6 illustrate the conversation networks of Kassi and YOU respectively. From these two figures, we find that both Kassi and YOU conversation networks are sparse (low network densities). Both networks have a few leader users with high degree centralities, who are mainly the project members of the social media services.

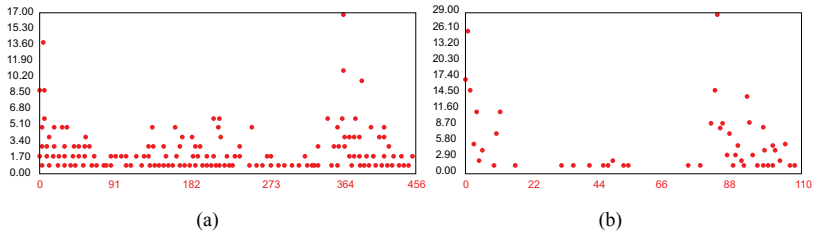
Figure 7 also shows that both Kassi and YOU conversation network densities are low (sparse). For Kassi, at beginning of the Kassi public release, a few users act as leaders by overshadowing other users by their higher degree centrality and betweenness centrality because of the promotion activities. With the time went by, the behaviour of users in Kassi network become more similar after that. For YOU, the group degree and betweenness centralities are almost horizontal, which means the conversation activities are inactive. Later the degree and betweenness centralities of YOU go up slightly. It may relate to new rounds of promotion activities.

**Figure 7** Comparison of betweenness (red), degree (blue) and density (green) of (a) Kassi and (b) YOU conversation networks (see online version for colours)



Both Aalto and BUPT universities have made several rounds of promotion activities for Kassi and YOU respectively. Figure 8 shows that on promotion periods (at the beginning of semesters), there are conversation activity surges and between the promotion periods, daily conversations are quite steady in Kassi and YOU. Comparatively, the daily conversations are even less and intermittent in YOU.

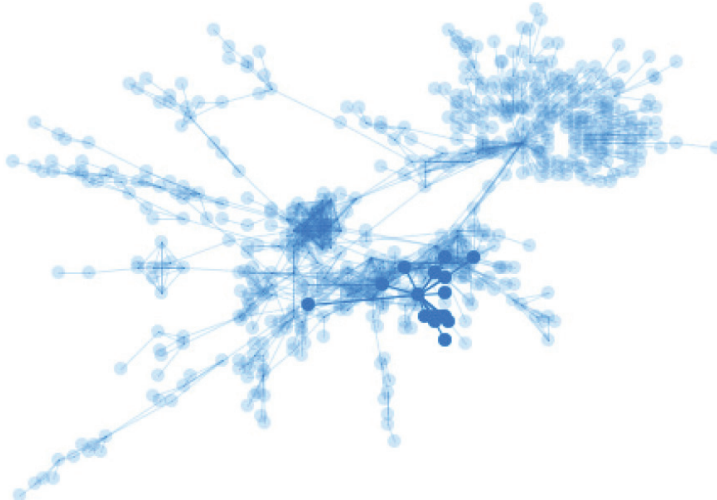
**Figure 8** Comparison of daily new conversations in (a) Kassi and (b) YOU (see online version for colours)



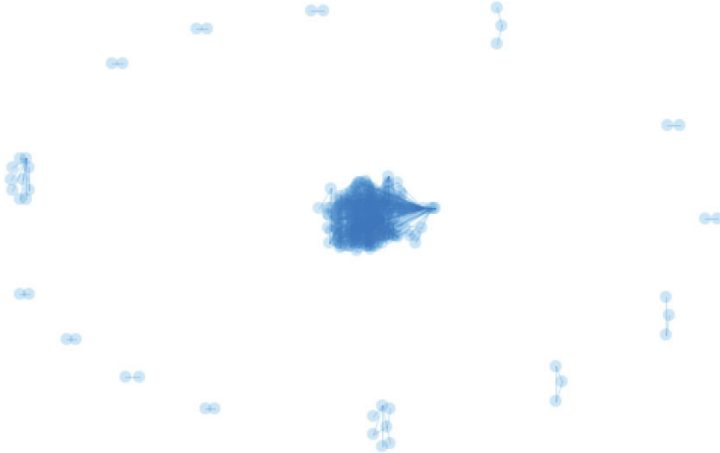
#### 4.2 *Friending behaviour*

A friendship network is a one-mode network which means the subjects of SNA belong to a single set, and an undirected network which means if actor A is a friend of actor B, then actor B is also a friend of actor A (Wasserman and Faust, 1995).

**Figure 9** Kassi friendship network (see online version for colours)



**Figure 10** YOU friendship network (see online version for colours)



Figures 9 and 10 shows the Kassi and YOU friendship networks respectively. We can see that only a few lead users are active (with high degree centrality), while most users in both Kassi and YOU are not active in making friends. However, we can also see the differences between Kassi and YOU friendship networks. In Kassi, the whole friendship network is connected, while in YOU, there are several isolated sub-groups or sub-networks around the central network. The reason might relate to the comparative short time of operation of YOU service.

Figure 11 shows the comparison of betweenness, degree and density of Kassi and YOU friendship networks. We can see that both friending activities become inactive or stagnant after public release of the services.

**Figure 11** Comparison of betweenness (red), degree (blue) and density (green) of (a) Kassi and (b) YOU friendship networks (see online version for colours)

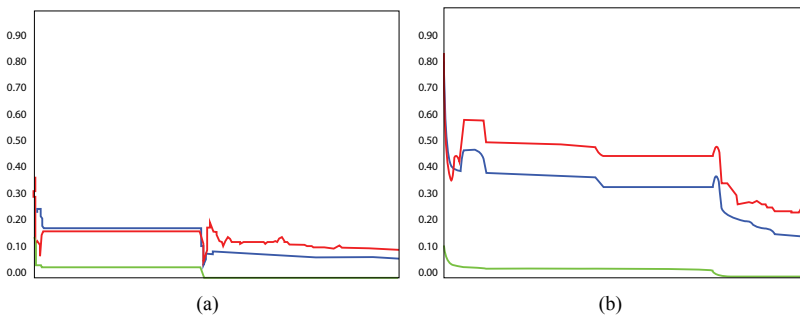
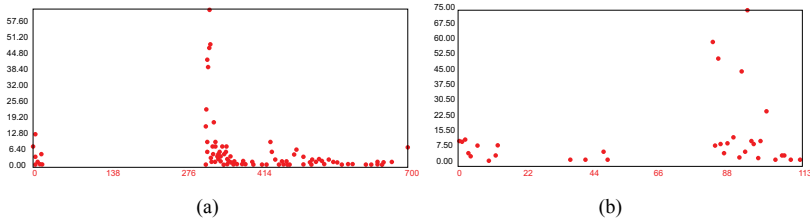


Figure 12 shows the comparison of daily new friendships in Kassi and YOU. It further confirms that the friending activities are in active after the promotions. Comparatively, the friending behaviour in YOU is even less and intermittent.

**Figure 12** Comparison of daily new friendships in (a) Kassi and (b) YOU (see online version for colours)



### 4.3 Grouping behaviour

In Kassi and YOU, registered users can create their own groups or join existing groups. The group network is a two-mode network because the relationship is between two sets namely the users and the groups (Wasserman and Faust, 1995).

**Figure 13** Kassi group network (see online version for colours)



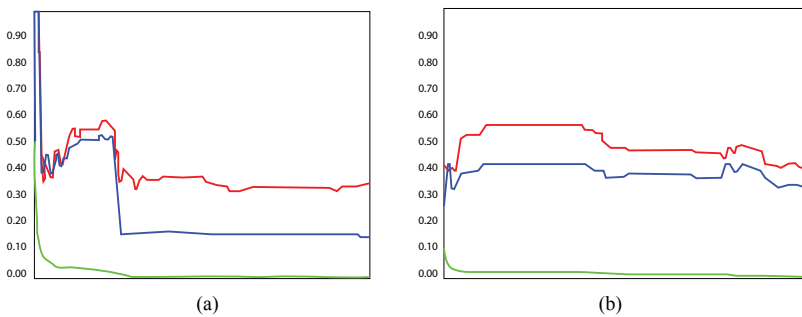
**Figure 14** YOU group network (see online version for colours)

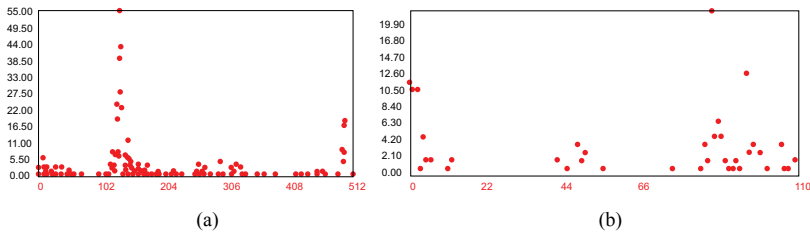


Figures 13 and 14 show the group networks of Kassi and YOU respectively. Kassi has 58 groups, while YOU has 35 groups. The phenomenon of users' copresence in multiple groups, which is popular in Facebook (Lampinen et al., 2009), is not common in Kassi and YOU. Most users are only in one or two groups.

Figure 15 shows that the grouping activities are inactive or stagnant in both Kassi and YOU after their public release. Figure 16 shows that there are some group activity surges around each round of promotion periods. However, between the promotion periods, the grouping activities are quite inactive.

**Figure 15** Comparison of betweenness (red), degree (blue) and density (green) of (a) Kassi and (b) YOU group networks (see online version for colours)



**Figure 16** Comparison of daily new grouping activities in (a) Kassi and (b) YOU (see online version for colours)

#### 4.4 Correlation analysis

##### 4.4.1 Reciprocity

Reciprocity or mutualism is a phenomenon which has been observed in many online communities (Iriberri and Leroy, 2009; Wang and Fesenmaier, 2004). In order to measure reciprocity, we make Pearson correlation analyses between the offers and requests and between the conversation in-degrees and out-degrees by SAS.

Table 2 shows that there are strong positive correlation between offers and requests and between conversation in-degrees and out-degrees. Earlier Kassi user researches also find out that reciprocity is a key factor for user's participation motivations (Kuikka et al., 2011; Suhonen et al., 2010).

**Table 2** Correlation analysis for reciprocity

	<i>Coefficient</i>	<i>Significance</i>
Kassi offers and requests	0.511	< .0001
Kassi in-degrees and out-degrees	0.552	< .0001
YOU offers and requests	0.436	< .0001
YOU in-degrees and out-degrees	0.502	< .0001

##### 4.4.2 Social networks and exchanging activities

As we introduced in the Section 2, besides the core exchanging service, Kassi and YOU also support social networking functionalities. Then one interesting question is whether the social networks such as friends and groups correlate with the exchanging activities. For example, whether the friendship and group relationship will help or contribute exchanging relationship or behaviours. As the 'relationship' data per se are the data about 'correlation' which violates the rule of 'collinearity', many traditional statistics techniques (e.g., the ordinary least squares) cannot be used. A randomisation test method called 'QAP' was widely used in SNA for this situation (Simpson, 2001).

We use UCINET 6 for the QAP analysis. The main results are shown in Table 3. From Table 3, we can see that friendships and groups are not correlated with current Kassi and YOU core service usage, namely the exchanging relationship. In fact, Figure 11 and Figure 15 also suggest this result. Figure 11 and Figure 15 show that

degree and betweenness centrality lines are almost horizontal (unchanged) after the public release of Kassi and YOU.

**Table 3** Correlation analysis for social networks and exchanging behaviours

	<i>Obs value</i>	<i>Significance</i>
Kassi friendship and exchanging	0.237	0.312
Kassi group and exchanging	0.285	0.084
YOU friendship and exchanging	0.476	0.261
YOU group and exchanging	0.583	0.121

## 5 Discussion and future work

### 5.1 Discussion

First, we discuss the our findings in Section 4 and their implications. From exchanging behaviour analysis, we know that the top discussion terms in Kassi and YOU show strong locality features which are closely related to the local contexts and cultures. For example, it seems that in Kassi, users more tend to make transactions (buying and selling) than users in YOU. This might relate to the culture differences between Finland and China. Another difference is that in Kassi, top discussions relate to housing (e.g., renting or sharing apartments), while in YOU, top discussions relate to information and books. This difference might relate to the context difference. Many Aalto University students have to rent or share apartments for the limited university accommodation resources, while in BUPT, almost all students live in university dormitories by our preliminary investigation. Comparatively, Kassi has more discussions than YOU. YOU more exclusively focuses on resource sharing (e.g., books), while Kassi has more service sharing.

From the conversation network SNA analysis, we can see that after the public release of Kassi, users exchanging behaviour becomes more similar as conversation network betweenness decreases. However, the conversation network betweenness curve of YOU go up slightly during half year time span. This may relate to the promotion activities in which lead users dominate the network. From correlation analysis, we know that users' conversations are strong positively correlated with users' requests and offers and there are reciprocal relationship between requests and offers. Therefore, to improve Kassi and YOU service usages, it is important to extract users' requirements at the points of interest in their daily lives and further facilitate users to post their requirements and offers in Kassi and YOU.

From the friending behaviour analysis and grouping behaviour analysis, we know that friending and grouping behaviours become stagnant after the public release. The correlation analysis between social networks and conversations further confirm that currently there are not much correlations between social networks and users' exchanging behaviour. Possible reasons for this result are as follows:

- 1 Currently, majority of Kassi and YOU service usages are related to physical items than intangible services, which may more related with utility than social value (Suhonen et al., 2010; Kuikka et al., 2011).

- 2 Kassi and YOU are local (campus-based) social media services. Trust is not an issue if compared with large-scale social media like Facebook.
- 3 Because of the critical mass, social networks in small local social media may not be very attractive to users as them in large-scale social media.

From Figures 7, 11, 15, we see that betweenness centralities of conversation, friending and grouping activities in YOU are much higher than in Kassi. This shows that compared with Kassi, the activities in YOU are more influenced or dominated by project members for promotion.

## 5.2 *Future work*

Currently, SMS function for Kassi and a mobile version of Kassi is under active development to further facilitate users to post their requests and offers at the points of interest. Kassi and Facebook APIs integration is also under active development to facilitate users to take advantages of existing Facebook social networks. In future work, we will analyse whether and how Facebook social networks will contribute to Kassi service usage.

Drawing on the earlier user research on Kassi (Suhonen et al., 2010; Kuikka et al., 2011), we have done a similar user research by interview and survey to understand the differences in service adoption in Kassi and YOU. In future work, we will do a comparison between the service adoption in Kassi and YOU.

There are other interesting future research directions:

- the comparison between local social media and global social media – for example, the evaluation of the users' behaviours within the local social media can be compared with some other global social media (e.g., Facebook and Twitter) containing the same users.
- the influence of culture differences on user behaviour – for example, how users from different culture background modify their behaviour to conform to the behaviour of others when living in a new culture environment?

As the international collaborations of OtaSizzle project, Kassi currently is being replicated in UC Berkeley University in USA and Nairobi University in Africa (Tang et al., 2010). In future work, we will also compare the user behaviours and service usage differences in these different cultural contexts. Taking into consideration of the results in this paper, we have some preliminary estimations and suggestions on the replication in various user groups:

- Pay more attention to the utility (e.g., make exchanging process easier) than the social value of the platform.
- Instead of developing another set of local social networking functionalities, taking advantage of the existing popular social networking platforms such as Facebook and Twitter.
- Culture and context have important influence on users' behaviour. Instead of the copying the services, customising them according to the real culture and context features.

## 6 Conclusions

This paper uses SNA and correlation analysis to analyse different user behaviours and their correlations in two campus-based local social media services for exchanging goods and services in Finland and China. We also discuss the implications of our findings and future work.

## Acknowledgements

This work has been supported by the OtaSizzle research project, which is funded by the Aalto University's 'Technology for Life' campaign donations from private companies and communities. The authors would like to thank Antti Virolainen and Juho Makkonen for providing the Kassi datasets and Qing Xu for providing the YOU datasets. The authors would also like to thank the editor and the two anonymous reviewers for their valuable comments and suggestions to improve the paper.

## References

- Benevenuto, F., Rodrigues, T., Cha, M. and Almeida, V. (2009) 'Characterizing user behavior in online social networks', *Proceedings of the 9th ACM SIGCOMM Conference on Internet Measurement Conference*, ACM, pp.49–62.
- Borgatti, S., Everett, M. and Freeman, L. (2002) *Ucinet for Windows: Software for Social Network Analysis*, Harvard Analytic Technologies, Harvard, MA.
- Brandes, U., Kenis, P., Lerner, J. and Van Raaij, D. (2009) 'Network analysis of collaboration structure in wikipedia', *Proceedings of the 18th International Conference on World Wide Web*, ACM, pp.731–740.
- Gloor, P. and Zhao, Y. (2004) 'Tecflow-a temporal communication flow visualizer for social networks analysis', *ACM CSCW Workshop on Social Networks (ACM CSCW Conference)*, Chicago, p.6.
- Gruzd, A. and Haythornthwaite, C. (2008) 'The analysis of online communities using interactive content-based social networks', *Proceedings of the American Society for Information Science & Technology (ASIST) 2008 Conference*.
- Haythornthwaite, C. and Gruzd, A. (2007) 'A noun phrase analysis tool for mining online community conversations', *Communities and Technologies 2007*, pp.67–86.
- Iriberry, A. and Leroy, G. (2009) 'A life-cycle perspective on online community success', *ACM Computing Surveys (CSUR)*, Vol. 41, No. 2, pp.1–29.
- Java, A., Song, X., Finin, T. and Tseng, B. (2007) 'Why we twitter: understanding microblogging usage and communities', *Proceedings of the 9th Web KDD and 1st SNA-KDD 2007 Workshop on Web Mining and Social Network Analysis*, ACM, pp.56–65.
- Kuikka, M., Tuunainen, V. and Suhonen, E. (2011) 'Motivations for and barriers to the use of social exchange in online communities: case Kassi', *2nd Scandinavian Conference on IS and the 34th IRIS Seminar*.
- Lampinen, A., Tamminen, S. and Oulasvirta, A. (2009) 'All my people right here, right now: management of group co-presence on a social networking site', *Proceedings of the ACM 2009 International Conference on Supporting Group Work*, ACM, pp.281–290.
- Maia, M., Almeida, J. and Almeida, V. (2008) 'Identifying user behavior in online social networks', *Proceedings of the 1st Workshop on Social Network Systems*, ACM, pp.1–6.

- Mäntylä, M., Hämäläinen, M., Karhu, K., Lampinen, A., Lehväslaiho, K., Nuutila, E., Oulasvirta, A., Pitkänen, O., Sarvas, R., Suhonen, E., Tuurunen, J., Törmä, S. and Virolainen, A. (2009) 'Sizzlelab: building an experimentation platform for mobile social interaction', *MobileHCI'09*, Bonn, Germany.
- Safko, L. and Brake, D.K. (2009) *The Social Media Bible: Tactics, Tools & Strategies for Business Success*, John Wiley & Sons, Hoboken, NJ.
- Simpson, W. (2001) 'The quadratic assignment procedure (QAP)', *North American Stata Users' Group Meetings 2001*, Stata Users Group.
- Singla, P. and Richardson, M. (2008) 'Yes, there is a correlation:-from social networks to personal behavior on the web', *Proceeding of the 17th International Conference on World Wide Web*, ACM, pp.655–664.
- Suhonen, E., Lampinen, A., Cheshire, C. and Antin, J. (2010) 'Everyday favors: a case study of a local online gift exchange system', *Proceedings of the 16th ACM International Conference on Supporting Group Work*, ACM, pp.11–20.
- Tang, T., Wu, Z., Karhu, K., Hämäläinen, M. and Ji, Y. (2010) 'An internationally distributed ubiquitous living lab innovation platform for digital ecosystem research', *Proceedings of the International Conference on Management of Emergent Digital EcoSystems*, ACM, pp.159–165.
- Viswanath, B., Mislove, A., Cha, M. and Gummadi, K. (2009) 'On the evolution of user interaction in Facebook', *Proceedings of the 2nd ACM Workshop on Online Social Networks*, ACM, pp.37–42.
- Wang, Y. and Fesenmaier, D. (2004) 'Towards understanding members' general participation in and active contribution to an online travel community', *Tourism Management*, Vol. 25, No. 6, pp.709–722.
- Wasserman, S. and Faust, K. (1995) *Social Network Analysis: Methods and Applications*, Cambridge University Press, New York.