

Emerging Leadership in an Online Community: A Longitudinal Network Analysis

Joyce Yi-Hui Lee
Yuan-Ze University
yhl@saturn.yzu.edu.tw

Chin-Sheng Yang
Yuan-Ze University
csyang@saturn.yzu.edu.tw

Carol Hsu
Tongji University
carolhsu@tongji.edu.cn

Jhong-Heng Wang
Yuan-Ze University
s900045@gmail.com

Abstract

Online communities have brought great benefits to society; however, relatively few of them are successful in sustaining community activities. It is necessary to have a better understanding of the contextual development of online communities. This study adopts the theory of networked influence to address the research objective. Data is collected from an online community which has been in operation for ten years. We investigate the community's sustainability on a longitudinal basis, focusing on its dynamic temporal development, with regard to how it was formed, became robust, and either declined or was sustained. Adopting social network analysis with a qualitative approach, we identify several types of emerging leaders and how the "relay events" between them had a significant impact on communication prolongation. Their influence is found to extend across discussion entities, resulting in communication homogeneity, and leading to significant network effects that are relevant to participants' interactions.

Keywords: Online community, networked influence, online discussion forum, social network analysis, content analysis

1. Introduction

Social media have become an important online social venue where people can connect and communicate. In particular, online communities have enabled people to find others with common interests, passions, questions or problems, and, subsequently, to share information and knowledge as well as give mutual support. Thus, an online community refers to any virtual social space where people get together to find company and share information and support [1].

By connecting with known or unknown others in these communities, one's knowledge can be publicly visible through a variety of online messages being posted, read and shared [2, 3]. Since this kind of social media can provide significant value for the users, it can also become a great benefit to society, i.e., an important social capital across multiple dimensions [see 4 for a review]. However, despite the increasing value online communities bring to society, researchers have noticed that participants are not necessarily as active as has been believed [5-7]. Studies have found that many online communities have turned into "cyber ghost towns" [8] which no longer serve as conduits for online communication or knowledge sharing [2, 9, 10].

The question regarding how online communities can be sustained has attracted much research attention. This is evident in the growing number of studies that focus on topics such as how community members are recruited and maintained [11, 12], the driving forces that enhance member participation [8, 9], the identification of influencers who lead or encourage member participation and retention [13, 14], and the interactions between the influencers and those being influenced [15, 16]. This "networked influence" [17, 18] indicates network patterns in which one influences the behavior of others in the networked environment, and is considered to be critical to the sustainability of online communities. Based on the theory of networked influence, this study addresses the challenges of sustaining online communities by answering the following question: How does participant communication and influence in a networked environment lead to the emergence of leaders, which consequentially sustains the online community?

We investigated an online automobile community centered on the model N1 (a pseudonym) that emerged from the online discussion forum URcar

(also a pseudonym). The N1 automobile community has attracted a large number of automobile amateurs and experts who repeatedly and continuously post their opinions and user experience. This community began with a discussion board entitled “N1 owners, please sign in here” (abbreviated to Sign-in), which we selected as the main case, as it was the longest car-related discussion on this forum. The discussion has lasted for about 10 years, beginning in February, 2007, and is still active. As the research progressed, three other discussion boards (abbreviated as “Car-life,” “Life-together,” and “DIY”) were seen to be relevant to the N1 discussions. These four discussion boards formed the N1 community. To more comprehensively understand this community, we collected all the online posts from the four discussion boards, which comprised 1,077 participants and 15,959 messages. Using this substantial dataset, we discovered how this community emerged, developed and then was sustained over such a long period of time.

We conducted social network analysis with qualitative content analysis. Adopting this joint method gave us a clearer understanding of the dynamic changes in the influence networks constructed by the participants. We investigated the temporal development of the community and identified specific participant roles that are influential in sustaining the online community, as well as the network effects brought by those roles. This research revealed several interesting findings. First, we identified several types of emerging leaders (i.e., “generous question respondents,” “cross-boarders,” and “social bond” leaders) and the relay events between them that have a significant impact on the prolongation of online communication. Second, we found that their influence extends across different discussion boards, resulting in an increasing homogeneity of networked communication that enhances participants’ interactions. Lastly, we found that cross-board communication leads to a “network migration” that is relevant to the community’s sustainability. We believe that these findings contribute to the field of online community by combining the investigation of dynamic changes with the cross- discussion board phenomenon.

In the following, we discuss the relevant literature regarding online community sustainability and the theory of networked influence. We then explain the research methodology, including the data collection and analysis, after which we present and discuss the research findings. The paper concludes with the theoretical and practical implications, along with proposed directions for future research.

2. Literature Review

Although the popularity of social media has led to exponential growth in the volume and significance of online communities, a body of literature has argued that managing this form of community involves challenges regarding user participation, membership retention and community sustainability. In an open communal environment, participants can join and leave freely without obligation [19], and such communities are usually managed and run by the members themselves [2] without obvious organizers [20]. Community activities can become hit-or-miss affairs, which can discourage people from contributing valuable information [21]. Moreover, as most participants are unlikely to know each other in person, they may have difficulty developing stronger levels of individual trust [22]. Also, participants do not share “institution-based trust,” because the forums are not created for any organizational goal [23]. As a result, despite their increasing growth for multiple purposes, relatively few online communities have been successful in enhancing user participation and interactivity [7, 8] or facilitating knowledgeable conversations [2, 24].

In order to better understand online community sustainability, previous studies have investigated user participation with regards to membership retention. In their work on knowledge gaining and learning processes in online communities, Lave and Wenger [25] identified the behaviors of a spectrum of participant types that ranged from “newcomers” to “full participation.” This precipitated the identification of the dynamic changes in participant roles. Kim [11] differentiated several participant roles: visitors, novices, regulars, leaders, and elders. Preece and Schneiderman [26] proposed a reader-to-leader framework based on the degree of participant involvement. These proposed frameworks start from a reader type, who only consumes content. This type is followed by the casual user, who invests some time and effort in making small contributions and carrying out minor acts of participation in a community. The frameworks then continue with more serious users who invest significant time and effort in community participation, culminating in a member who creates significant content, and leads and moderates discussions in the community. It has been argued that users who invest more effort in an online community and participate in online communication more actively are easily identified as online leaders who add more value to the community [9].

Prior research suggests that online leaders play an important role in sustaining an online community. They are able to induce a large number of members

to participate [27, 28], thereby enhancing knowledgeable conversations and the exchange of information [2]. High responsiveness and interactivity among participants are believed to be beneficial for community members [29, 30], since online communities are able to continue under such conditions [30].

In addition to the above literature concerning online leadership at the individual level with regard to the degree of involvement, another important research stream has further addressed the interpersonal processes that sustain online communities. In this stream, researchers have pointed out that since reciprocity serves as a driving operational force, online user participation is highly influenced by peers [10, 15, 31, 32]. Researchers have approached this from several angles, identifying the following: (1) leaders who encourage others to engage in conversations [33], (2) the characteristics and impact of such leaders on a community, e.g. super-posters who post a large number of messages and can dominate collective opinions [13], or silent leaders who encourage the others to express their opinions through information exchanges [14]; and (3) how such leaders influence the behavior of others (e.g., herding behavior [15]), and how those being influenced react (e.g., community member adaptation, addressed by Welbers and Nooy [34]).

In this research, we drew on theory of networked influence to examine the emergence of leaders and the interaction between these leaders and participation. This theoretical perspective [17] allows us to study interpersonal behavioral patterns in terms of the actions and interactions of a leader in a networked situation, rather than in isolation [32, 35]. It also offers a perspective on how one leader's behavior can influence others and bring about a structural change [36]. Hara and Hew [24] studied online conversations and analyzed participants' interactive communication. Their study focused on knowledge sharing, and their results indicated that when knowledge seekers post questions or request help from the community, a knowledge provider might share his/her knowledge in the form of a story describing a similar experience in which he/she worked out a solution to the problem. Such interactions are particularly important for knowledge sharing in online communities, because knowledge is created and accumulated predominantly through high levels of interaction and the dynamic reciprocity of participants' online conversations [2, 18, 37]. Based on the networked influence theory, we consider interpersonal behavior from the perspective of online conversations to be relevant to this present study.

3. Research Methods

We collected data from "URcar," a popular online discussion forum in Taiwan. Specifically, the online community centered on the vehicle model "N1" was selected as the case for this study. This community was formed by four discussion bulletin boards relevant to the N1 discussion, which are entitled as follows: "N1 owners, please sign in here," "[Car Life] the first generation of the N1 produced in early 1996 is still working," "The automobile republic of N1 MAX," and "N1, an energy efficient vehicle and its DIY." In this report, these are abbreviated to "Sign-in," "Car-life," "Life-together," and "DIY," respectively, and the names of the participants have been replaced with pseudonyms.

In order to analyze the content of the communication within the online community, we collected the textual data of the online posts. The basic information of a post includes user name, user portrait, date, time, an ordinal number, and the main text of the post. Given the great volume and rich content of the dataset, this case provides a good opportunity to study online community sustainability over time.

To address the research objectives, methodologically we applied social network analysis with qualitative content analysis. We investigated the social networks in a community that emphasizes the post-and-reply approach. This included people who posted messages, who replied to one another, whose messages were cited, and who asked or answered questions directly. In the social graphs illustrated in this report, the nodes represent individuals who posted messages, and the lines are the links between the individuals based on questions asked and replies. Also, the size of the nodes reflects the number of an individual's posts, while the thickness of the lines pertains to the level of the individual links (number of interactions). UCINET software was adopted to assist in our organizing and managing the dataset.

4. Analysis and Findings

Over a period of ten years, participants came and left, with some continuously posting messages, while others participated intermittently and still others stopped posting altogether. When considering the overall number of participants and posts, the 10-year development of the online community can be divided into three stages: developing, active and declining.

The Developing Stage: The Frequent Knowledge Contributors emerge as community leader

When the Sign-in discussion board was initiated in 2007, it attracted dozens of N1 car owners who posted their cars' background information. The participants kept posting messages without making replies or being replied to by others. Consequently, conversations among these initial users were not interactive. Nevertheless, when some people started to raise questions about their cars' maintenance issues and received useful feedback from others, the atmosphere of a knowledge sharing community began to emerge. That is, some posted messages and others replied, allowing information and knowledge about the N1 to be exchanged among the posters. Although two-way conversations emerged, these intercommunications took the form of simple questions and answers (Q&As). The Q&A-like interactions did not extend into long threads, typically ending within three posts. The messages posted by Airtiger and Pink below show the nature of the knowledge sharing in the communal environment.

[Airtiger wrote on Sign-in, 13.02.2007, #15] My N1 was made in 1999. I like it very much as it is very quiet when I'm driving, and that makes my family and myself very comfortable... Although I like its quietness, it sometimes makes me annoyed to hear noises clearly even though they are low volume... Recently, I have had a problem of a noise coming from the dashboard area, but I have no idea what causes the noise.....

[Pink replied to Airtiger on Sign-in, 14.02.2007, #16] I have never had such a problem, but I suppose that the noise may have two possible causes: a tire or the transmission shaft... The first can be sorted out easily, but if it is because of the second situation, it could be a serious problem. It would be best for you to find a garage to check your car thoroughly.

[Airtiger replied to Pink on Sign-in, 14.02.2007, #17] Thanks for your reply. I am sure that the noise is from my dashboard, not somewhere else. But you are right, I definitely need to find a garage to carefully check out my car.

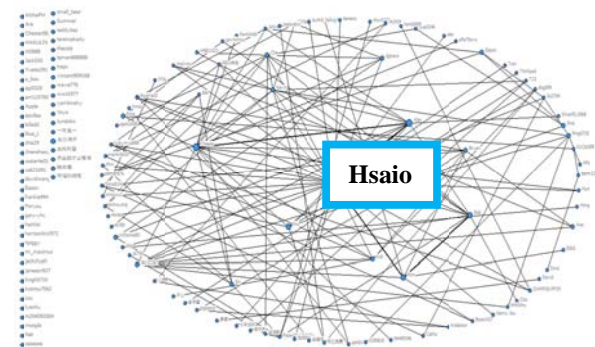
Moreover, we noticed that as participants gradually became involved in the discussions, Sport, who had initiated this discussion board, became invisible and did not post any messages apart from those he had posted to initiate Sign-in. This discussion board became self-organizing without the board creator's involvement. Nevertheless, we identified a person named Hsaio who frequently posted messages and appeared to play a central role in the networked communication. As Figure 1 shows,

he played a significant role in terms of the quantity of posts and had higher centrality than the others.

Hsaio played a central role in the networks throughout the time period of 2008-2012. Figure 1 shows the participants' network for 2011, the year with most people involved in this stage. Analysis of the content of Hsaio's posts reveals that he had used them to give detailed answers to others who drew on his professional knowledge. In the example below, he gives a detailed explanation to Cheese about how a generator can be fixed. The original message was about 600 words; it is abbreviated here to clarify the purpose of the message.

[Hsaio replied to Cheese on Sign-in, 04.11.2008, #333] If it is because the electronic generator has broken, it would not show just a flickering warning light on the dashboard.

The battery has a function to keep the voltage stable. If the generator breaks down while the engine is still working, only the engine light will be turned on and the car will still be functioning. You need to check the circuits. A new Shihlin-branded generator with control lines will be just about 3,000 dollars. When you replace it, you must... I did it by myself.



User ID	Number of post	Degree	nDegree	Betweenness	nBetweenness
Hsaio	51	41	0.045	1402.71	6.032
Cheese	27	23	0.025	1164.938	5.009
Alex	23	18	0.02	367.384	1.58
Mimi	21	18	0.02	258.342	1.111
snsv01ll	17	11	0.012	361	1.552
eebad	15	16	0.017	354.852	1.526
aidi	13	9	0.01	99.367	0.427
chengg	13	14	0.015	476.606	2.049
Jay	13	13	0.014	235.85	1.014
kevin	12	13	0.014	635.225	2.731

Figure 1. Participants' networks during the developing stage (for 2011)

Hsaio's detailed instructions for replacing the generator were appreciated by Cheese, who had raised the question. We found that, at this stage, even though the conversations were not especially interactive, a supportive community was gradually

being formed by the participants. Since Hsaio played a central role, the Sign-in discussion became a very “Hsaio-centric” networked communication.

The Active Stage: The Cross-boarders led to Homogeneity of Networked Communication

Participants’ interactions became more active between 2012 and 2014, averaging more than 1,000 messages posted by more than 200 people, and 100 or more newcomers joined in these discussions. We found that three other discussion boards related to the N1 appeared to be highly connected with the focal discussion board (i.e., Car-Life, Life-together, and DIY).

Content analysis of the posted online messages revealed that a small group of “cross-boarders,” who were wandering among the discussion boards, played significant roles. That is, their activity encouraged others to communicate across different discussion boards and led to the homogenization of the content of the communication in this community.

The conversation below between Niko and Gold on Sign-in shows the occurrence of cross-board communication. When Niko claimed to have read through all the posts in this board, Gold suggested reading more on another board (i.e., Life-together) and jokingly welcomed Niko aboard.

[Niko wrote on Sign-in, 06.09.2014, #6860] Finally!! I have read through all the 6,000 posts and more!! I’ve learned a lot about the maintenance skills and smart tricks to keep my car in good condition. Thank you for all sharing.

[Gold replied to Niko’s post on Sign-in, 06.09.2014, #6861] haha... congratulations. But you haven’t finished yet as you have another important board to conquer: Life-together created by Master Su... You carry on. You will catch up with us.

The message below also shows that the users were familiar with where the information could be found. In this case, Tom suggests to the others to read posts on the other discussion board where they might find more useful knowledge.

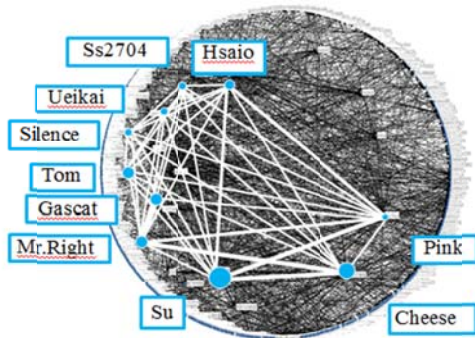
[Tom wrote on Sign-in, 31.08.2014. #6818] [Tom replied to a question asked by Cheese]... This is the simplest way to sort out that problem. If you want to deal with it more professionally, you can use a multi-meter. For that, you can find information at DIY, where Mr.Right has provided a lot of useful information regarding the solution to this problem.

The content of the online posts clearly indicates that participants were becoming familiar with those who were knowledgeable about particular car issues.

[Handsome wrote in DIY. 07.02.2014, #216] ... For this issue, you might like to refer to the other discussion board, Life-together. There, you will find an expert called Su, who is very knowledgeable about related issues...

The number of cross-boarders was not large (Figure 2 shows some of them), but their frequent posts quantitatively dominated the online discussions. In our study, they comprised 14.67% of the participants (158 cross-boarders), produced 80.18% of all posts, contributing over 95% of the posts in October, 2013. Their frequent posting was considered to be positive for the development of this community, as (1) they generously shared professional knowledge as well as the tricks of the trade based on personal experience, which led them to become important knowledge contributors; and (2) they told newcomers where to find the knowledge they needed from the large bulk of posted information, or recommended experts who might have the know-how to resolve their car problems. Thus, they played an important role as information navigators. Moreover, while they might be more active on one discussion board than on the other boards, their guidance for others looking for possible solutions usually led across the different boards. The occurrence of cross-board communication clarified the importance of considering the four discussion boards as a whole, rather than as independent discussion entities. Taking into consideration the cross-board communication, we have illustrated the four-board community as a whole (Figure 2).

Our exploration of the cross-board network (Figure 2) showed us that we had almost misunderstood the situation, believing that the influencing power of Su and his discussion boards (i.e., Car-life and Life-together) were fading away. In fact, Su’s influence remained and he played an important role in terms of the quantities of posts, and the high degree of centrality and betweenness.



User ID	No. of post	No. of participated boards(all)	Degree	nDegree	Betweenness	nBetweenness
Hsaio	604	3(3)	541	0.002	24586.834	5.956
Pink	447	3(4)	482	0.002	30240.111	7.326
Cheese	866	4(4)	870	0.003	12069.138	2.924
Su	1851	3(3)	1623	0.006	32966.297	7.986
Mr.right	732	3(3)	551	0.002	18874.225	4.572
Gascat	752	3(3)	861	0.003	61261.875	14.84
Tom	742	3(4)	771	0.003	25543.732	6.188
Silence	447	2(2)	420	0.002	8486.521	2.056
Ueikai	570	4(4)	560	0.002	5360.339	1.299
Ss2704	228	3(4)	246	0.001	7892.03	1.912

Figure 2. The cross-board networking during the active stage

The Declining Stage: Contagion of Idiosyncratic Communication for strengthen social relationships

Temporary changes within this community become clear when we take into account the long term postings data for the focal boards. Nevertheless, we noticed that while the overall discussion declined from 2015 onward, the performance of the DIY board was significantly different from that of the others. That is, while the overall discussion was declining on Sign-in, Car-life and Life-together, the number of posts, participants and newcomers in DIY continued to increase. Content analysis of the online posts revealed that the board creator, Mr.Right, had a particular form of leadership behavior that involved an idiosyncratic communication style, which led to his discussion board remaining interactive. The dynamic networks of DIY between 2013 and 2015 show an upward trend of development.

Table 1. Mr.Right' different communication styles on the different boards

Mr.Right on DIY	Mr.Right on Sign-in
<p>汽機車選購 最高2.4萬</p> <p>立法院交通委員會審議 道路安全管理處四種例外條文修</p> <p>一.汽車駕駛人任意以逃避、規避變化車道或其他不當方式</p> <p>途中任意驟然減速、煞車或於車道中暫停、處六千元以上二</p> <p>萬。</p> <p>二. 若汽車駕駛人爭道行駛佔用自行車專用道、妨礙通</p> <p>光以下罰鍰。自行車等機車駕駛、若未讓行人通行、或妨</p> <p>三.自行車相關罰鍰增加明確定法、應訂定專業輸入若行</p> <p>定標準、將處三百元以上六百元以下罰鍰、若能提測測</p> <p>四.機車行駛行人穿絲襪有行人穿絲襪或行駛至空橋口轉彎</p> <p>定將處三百元以上六百元以下罰鍰。</p> <p>五.未滿十八歲者、無人應同時應以道路交通安全講習、並</p> <p>好政策 🍌 🍌 🍌 🍌 🍌</p> <p>早該立這樣子的法令囉~~ 🍌 🍌 🍌 🍌 🍌</p> <p>推~~再推~~~又推推推 🍌 +1 🍌 +1 🍌 +1</p>	<p>對吧~~AUD的車子~~是吧~~</p> <p>那具行車電腦的設定.真的錯得離譜</p> <p>歐規的車.對於NO的排氣值特別嚴格</p> <p>可能是有LEAN-BURN的設定.造成汽汽太稀</p> <p>但是如果油氣過稀.也不太可能在解車時.就可讓那</p> <p>所以.AUDI的技師對於幾門的真正原因.可能另有</p>

當然OK,
農曆年前回斗六,
一定專車奉送(土炮油泥漿水)至您那兒
P.S.
俗話~~,真搞了一大堆的土炮玩藝,
氣乎在別人的車子上,成是比較看到見(省油率最
反而,自家阿肥,只是比以往好一些些 🍌
1000公里平均油耗,大約只提升3~4%(ECU電腦
五項土炮位像司如下:
(一)MOBIL 1號 0W-20水水等牌機油
(二)土炮二硝化鉍機油
(三)土炮汽油助燃劑
(四)土炮改良2號水燃器(最近用100%的酒精,省
(五)真空表==>最大真空值油門釋放
見且,
只要明例大腳,阿肥的ECU電腦就馬上噴重油
V6引擎,在市區或山區,比高速公路,踩大腳16
市區或山區,永遠是一隻大油虎 🍌 ==> 4-6k

還有教,
趁現在快去修,
最近車子千萬不要再開了

今天聽到一用CEFIRO的冷笑話
原本沒有會意過來,後來才~~通通~~它在講蝦米
台語:
CEFIRO VQ 有外厂X\ (外匯)DD 與 DET
兩款都是 大扭力與大馬力
那一款~~ 原起來 最爽~~
答案是~~DD~~原起來 ~勇厂X\ (菊花) 最爽
WHY?
因為 DD 是 缸 內直噴 🍌 🍌 🍌

請教大大,車廠有向您解說怠速抖動的原因嗎
花了五張小朋友,更換了什麼零件?
給車友一個參考,謝謝囉.



The influencing power of Mr.Right was noticeable in the content of his posts. We compared his posts on DIY and Sign-in, and identified his idiosyncratic communication style. Table 1 provides several typical examples by showing the original content of the posts so as to demonstrate the differences.

For his DIY posts, Mr.Right used many emoticons, different colors and special characters (e.g., Zhuyin, a phonetic symbol in Mandarin), but this communication style was not evident in his contributions to Sign-in. The idiosyncratic communication behavior consequently influenced the atmosphere of this discussion board, making it more free, casual and fun while continuing to discuss serious car problems. As the example below shows, Hsaio was also starting to use emoticons frequently in his posts on DIY.

[Hsaio wrote on DIY, 06.08.2014, #508] You are very welcome. 🍌 You are just the expert. 🍌 I have researched this car just for fun. Hahaha... 🍌

Hsaio often used emoticons to express his happiness on DIY, whereas his posts on Sign-in show no evidence of his emotions. This indicates the influence of Mr.Right on the style of Hsaio's posts on DIY. Moreover, this communication style was mimicked by others, as one message posted by KeiKei shows.





[KeiKei wrote on DIY, 05.01.2015, #992] Your car engine efficiency is getting better and better. I really envy you. 🍌 🍌 🍌 Can you share


your secret tricks with us, please?
 I also
 want my car be as efficient as yours.
 You really maintain your car
 well. Such envy...

Furthermore, Mr.Right welcomed newcomers and encouraged them to become involved in the discussions by ensuring that almost every post from someone new to the community received a response.

[Vincent wrote on DIY for the first time, 11.02.2014, #226] Regarding Gascat's suggestion, I can't agree more. He has provided very useful information, even more detailed than the car owners. We don't know each other but I do appreciate your information posted here.

[Mr.Right wrote on DIY, 11.02.2014, #227] Welcome, Vincent~ We are happy about your joining. Please come and sit. Have a cup of tea.

    [Mr.Right then also made a joke about Vincent's saying "I can't agree more" as Vincent said this sentence with English grammar that usually does not happen in Mandarin]. Your English must be good. Your thinking with English grammar is very interesting.

Happy Lantern Festival! 

Mr.Right and Vincent continued the conversations about the translations between English and Mandarin. Vincent then seemed to become more familiar with this discussion board and continued the conversations with Mr.Right with even more cheerful posts.

Moreover, it emerged that, on DIY, the leading behavior of including newcomers in the community was contagious. For instance, Mr.Right was the person who usually welcomed newcomers, but one day, another person took on the role, helping Mr.Right when he did not reply promptly. The example below shows how KeiKei took the place of Mr.Right in welcoming Breeze's participation.

[Breeze wrote on DIY, 03.12.2014, #905] Wow, I didn't know that there was such a useful discussion board here till now^^...I read through all the posts. That took me quite some time. Phew~ I just bought the car in October. I hope that I can learn more from you guys. ^^...

[KeiKei wrote on DIY, 03.12.2014, #906] Welcome! Welcome! We spread some flowers to welcome you!!

It is clear that Mr.Right's leadership behavior along with the specific communication style gave DIY a more cheerful atmosphere than that of the other boards. We also noted how the communication style introduced by the board initiator was mimicked, which appears to have had a bearing on the networked communication becoming more interactive.

We also found that the special communication style had a significant impact on the network structures. Users who participated in Sign-in moved to DIY. Mr.Right, Tom and Pink were very active in Sign-in but gradually moved to DIY and formed a robust network there. For example, Figure 4 shows the movement of the participants' network in Sign-in for May, 2014, and in DIY for July, 2014. We call this phenomenon of movement of participants and their networks "network migration."

As Figure 3 shows, participants who actively posted messages and interacted with others in Sign-in gradually moved to DIY and formed a robust network there.

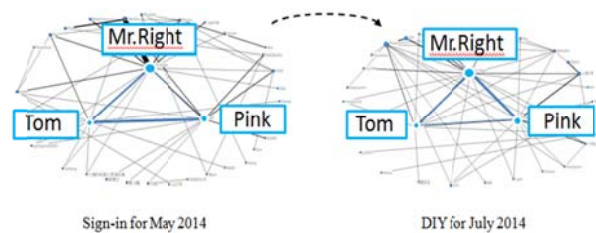


Figure 3. Network migration

5. Discussion and Conclusion

This study identified different types of online leaders, those who were more influential than other members and significantly contributed to sustaining the online community (see Table 2). We found that the sustainability of the online community was made possible by different actors bringing different forms of influence to the focal boards across the different development stages. First, the generous respondents to questions (e.g., Hsiao) led to the emergence of strong support, which gradually led to the formation of an online community. Second, the activities of cross-boarders (e.g., Cheese and Tom) led to the homogeneity of the content in the online communication, thereby showing that knowledge can be disseminated across discussion boards. Finally, a social bond leader (e.g., Mr.Right) with an idiosyncratic communication style changed the communication atmosphere, leading to the

phenomenon of network migration. With their involvement, the community was sustained by the “relay event” of the influencing roles.

Table 2. Summary of the research findings

Stage	The influencers and their characteristics	Network effect
Developing	Hsiao, and a few other frequent responders to questions, appeared to play central roles in the networked communication.	<ul style="list-style-type: none"> ■ Two-way conversations emerged, but they were generally Q&A-like. ■ A strongly supportive community was formed through the Q&As.
Active	A group of cross-boarders (Su, Cheese, Tom, etc.) who were generous knowledge contributors and information navigators had a high degree of centrality and betweenness in the networks.	<ul style="list-style-type: none"> ■ Cross-board communications became homogeneous. ■ Four discussion boards merged into one robust community.
Declining	Mr.Right, the DIY boards’ creator, behaved like a community leader with an idiosyncratic communication style.	<ul style="list-style-type: none"> ■ The phenomenon of network migration occurred: participants moved to DIY from Sign-in. ■ Fewer people were isolated, as newcomers were cared for and included in the network. ■ While communication was declining on most of the discussion boards, DIY sustained community members’ interactions.

We believe that our findings are of significance and contribute to the research field of online communities in several aspects. First, the research outcomes contribute to the discussion topic of online community sustainability. This study was carried out on a longitudinal basis and helps to provide a greater understanding of the temporal changes of an online community (with regard to how it develops, becomes robust, and declines) and the ways in which such communities can be sustained. In view of an insufficient understanding of network-level interaction dynamics, previous studies in this field have called for further research [30, 36, 38]. The findings of this current longitudinal study significantly increase our understanding of the dynamic nature of online communities.

Second, we have identified three types of online leaders whose influence on online communication going forward ensures that interactions will continue. From the theoretical perspective of participant roles, researchers have shown interest in identifying different typologies of online participants. Some have studied active participants, such as “super-posters” [13], while others have focused on inactive roles, e.g., “lurkers” [39]. In response to previous studies on participant roles, this study has determined that the volume of participation can be critical for a community. Nevertheless, more importantly, our research has found that the “relay event” between online leaders in different stages significantly impacts the development of an online community. Thus, the reason why some people in a networked environment matter more than others is not just about the number of participants or levels of participation: the manner in which they influence the community is also a factor.

Third, while some have contended that studying networked influence based on a standalone entity restricts our understanding of online communities [39, 40], this research responded by providing compelling evidence that one individual’s influencing power can be extended across different discussion entities (i.e., discussion boards, in our case) and, consequently, can significantly impact the nature of networked communication (i.e., communication homogeneity) and lead to changes in the network structures (i.e., network migration).

Prior research in this field has provided valuable insights into the sustainability of online communities. However, most of the literature has provided only a snapshot view, and has paid limited attention to their dynamic changes of such communities [19, 30, 36]. Our findings provide evidence that network patterns in the communal context rarely remain static, but rather are constantly changing. Conversations among

members are a sequence of events, not once-in-a-lifetime occurrences. Furthermore, this research shows that online communities do not typically form around a single conversation space, but are constructed and operated across different entities. Clearly, if we consider the development of networked influence as a standalone entity only, this would limit our understanding of online communities in the poly-contextual environment [28, 39, 41]. We believe that this study contributes to filling in that research gap.

We believe that our findings provide useful insights into the networked patterns offered by this form of online communities. However, this research still has a limitation in that we did not explore online communities in general, making it difficult to gauge the generalizability of our findings. Moreover, now that this rich dataset has been collected, deeper text analysis could identify different types of participation roles. Further research is needed with regard to the aforementioned research perspectives.

6. Acknowledgements

This research is funded in part by the Ministry of Science and Technology of the Republic of China under the grants MOST 105-2410-H-155-029 and MOST 103-2410-H-155-027-MY3.

7. References

- [1] J. Preece, "Sociability and usability in online communities: determining and measuring success," *Behaviour & Information Technology*, vol. 20, no. 5, pp. 347-356, 2001.
- [2] A. Majchrzak, S. Faraj, G. Kane, and B. Azad, "The Contradictory Influence of Social Media Affordances on Online Communal Knowledge Sharing," *Journal of Computer-Mediated Communication*, vol. 19, pp. 38-55, 2013.
- [3] J. W. Treem and P. M. Leonardi, "Social Media Use in Organizations: Exploring the Affordances of Visibility, Editability, Persistence and Association," in *Communication Yearbook 36*, C. T. Salmon, Ed. New York: Routledge, 2012.
- [4] V. Wickramasinghe and P. Welivitiyagoda, "Benefits gained from dimensions of social capital: a study of software developers in Sri Lanka," *Information Technology & People*, vol. 24, no. 4, pp. 393-413, 2011.
- [5] R. Benbunan-Fich and M. Loufaris, "An empirical examination of the sustainability of social bookmarking websites," *Journal of Information Systems and e-Business Management*, vol. 8, pp. 131-148, 2010.
- [6] J. Preece, B. Nonnecke, and D. Andrews, "The top five reasons for lurking: improving community experiences for everyone," *Computers in Human Behavior*, vol. 20, no. 2, pp. 201-223, 2004.
- [7] F. J. M. van Varik and H. van Oostendorp, "Enhancing Online Community Activity: Development and validation of the CA framework," *Journal of Computer-Mediated Communication*, vol. 18, no. 4, pp. 454-475, 2013.
- [8] C. W. Phang, A. Kankanhalli, and R. Sabherwal, "Usability and Sociability in Online Communities: A Comparative Study of Knowledge Seeking and Contribution," *Journal of the Association for Information Systems*, vol. 10, no. 10, pp. 721-747, 2009.
- [9] G. Oestricher-Singer and L. Zalmanson, "Content or Community? A Digital Business Strategy for Content Providers in The Social Age," *MIS Quarterly*, vol. 37, no. 2, pp. 591-616, 2013.
- [10] A. Quan-Haase, J. L. Suarez, and D. M. Brown, "Collaborating, Connecting and Clustering in the Humanities: A Case Study of Networked Scholarship in an Interdisciplinary, Dispersed Team," *American Behavioral Scientist*, vol. 59, no. 5, pp. 565-581, 2015.
- [11] A. J. Kim, *Community Building on the Web*. Berkeley: Peachpit Press, 2000.
- [12] C. Li and J. Bernoff, *Groundswell: winning in a world transformed by social technologies*. Boston: Harvard Business Review Press, 2008.
- [13] T. Graham and S. Wright, "Discursive Equality and Everyday Talk Online: The Impact of "Superparticipants", " *Journal of Computer-Mediated Communication*, vol. 19, pp. 625-642, 2014.
- [14] N. Panteli, "On leaders' presence: interactions and influences within online communities," *Behaviour & Information Technology*, 2016.
- [15] W. Oh and S. Jeon, "Membership herding and network stability in the open source community: The Ising perspective," *Management Science*, vol. 53, no. 7, pp. 1086-1101, 2007.
- [16] S. Reicher, S. A. Haslam, and N. Hopkins, "Social identity and the dynamics of leadership: Leaders and followers as collaborative agents in the transformation of social reality," *The Leadership Quarterly*, vol. 16, pp. 547-568, 2005.
- [17] A. Gruzd and B. Wellman, "Networked influence in social media: Introduction to the special issue," *American Behavioral Scientist*, vol. 58, no. 10, pp. 1251-1259, 2014.

- [18] W. Oh, J. Y. Moon, J. Hahn, and K. Taekyung, "Research note - Leader influence on sustained participation in online collaborative work communities: A simulation-based approach," *Information System Research*, vol. 27, no. 2, pp. 383-402, 2016.
- [19] S. Faraj, S. L. Jarvenpaa, and A. Majchrzak, "Knowledge Collaboration in Online Communities," *Organization Studies*, vol. 22, no. 5, pp. 1224-1239, 2011.
- [20] M. M. L. Wasko and S. Faraj, "Why Should I Share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice " *MIS Quartely*, vol. 29, no. 1, pp. 35-57, 2005.
- [21] W. G. Lutters and M. S. Ackerman, "Joining the backstage: locality and centrality in an online community," *Information Technology & People*, vol. 6, no. 2, pp. 157-182, 2003.
- [22] T. L. Thompson, "Work-learning in informal online communities" evolving spaces," *Information Technology & People*, vol. 24, no. 2, pp. 184-196, 2011.
- [23] A. Ardichvili, V. Page, and T. Wentling, "Motivation and barriers to participation in virtual knowledge-sharing communities of practice," *Journal of Knowledge Management*, vol. 7, no. 1, pp. 64-77, 2003.
- [24] N. Hara and K. F. Hew, "Knowledge-sharing in an online community of health-care professionals," *Information Technology & People*, vol. 20, no. 3, pp. 235-261, 2007.
- [25] J. Lave and E. Wenger, *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge University Press, 1991.
- [26] J. Preece and B. Schneiderman, "The Reader-to-Leader Framework: Motivating Technology-Meditated Social Participation," *AIS Transactions on Human-Computer Interaction*, vol. 1, no. 1, pp. 13-32, 2009.
- [27] K. de Valck, G. H. van Bruggen, and B. Wierenga, "Virtual communities: A marketing perspective," *Decision Support Systems*, vol. 47, pp. 185-203, 2009.
- [28] S. Ransbotham and G. Kane, "Membership turnover and collaboration success in online communities: explaining rises and falls from Grace in Wikipedia," *MIS Quartely*, vol. 35, no. 3, pp. 613-627, 2011.
- [29] R. Blom, S. Carpenter, B. J. Bowe, and R. Lange, "Frequent contributors within US newspaper comment forums: An examination of their civility and information value," *American Behavioral Scientist*, vol. 58, no. 10, pp. 1314-1328, 2014.
- [30] U. Pfeil, P. Zaphiris, and S. Wilson, "The role of message-sequences in the sustainability of an online support community for older people," *Journal of Computer-Mediated Communication*, vol. 15, no. 2, pp. 336-363, 2010.
- [31] W. A. Mason, F. R. Conrey, and E. R. Smith, "Situating Social Influence Processes: Dynamic, Multidirectional Flows of Influence Within Social Networks," *Personality and Social Psychology Review*, vol. 11, pp. 279-300, 2007.
- [32] B. Wellman *et al.*, "The Social Affordances of the Internet for Networked Individualism," *Journal of Computer-Mediated Communication*, vol. 8, no. 3, p. 0, 2003.
- [33] S. L. Johnson, H. Safadi, and S. Faraj, "The emergence of online community leadership," *Information Systems Research*, vol. 26, no. 1, pp. 165-187, 2015.
- [34] K. Welbers and W. de Nooy, "Stylistic accommodation on an Internet Forum as bonding: Do posters adapt to the style of their peers," *American Behavioral Scientist*, vol. 58, no. 10, pp. 1361-1375, 2014.
- [35] S. Sarker, M. Ahuja, S. Sarker, and S. Kirkeby, "The role of communication and trust in global teams: A social network perspective," *Journal of Management Information Systems*, vol. 28, no. 1, pp. 273-309, 2011.
- [36] S. Faraj and S. L. Johnson, "Network exchange patterns in online communities," *Organization Science*, vol. 22, no. 6, pp. 1464-1480, 2011.
- [37] D. Huffaker, "Dimensions of leadership and social influence in online communities," *Human Communication Research*, vol. 36, pp. 593-617, 2010.
- [38] S. I. Baek and Y. M. Kim, "Longitudinal analysis of online community dynamics," *Industrial Management & Data Systems*, vol. 115, no. 4, pp. 661-677, 2015.
- [39] J. Cranefield, P. Yoong, and S. L. Huff, "Rethinking Lurking: Invisible Leading and Following in a Knowledge Transfer Ecosystem," *Journal of the Association for Information Systems*, vol. 16, no. 4, pp. 213-247, 2015.
- [40] J. Cranefield and P. Yoong, "Crossings: embedding personal professional knowledge in a complex online community environment," *Online Information Review*, vol. 33, no. 2, pp. 257-275, 2009.
- [41] J. Preece and D. Maloney-Krichmar, "Online communities: Design, theory, and practice," *Journal of Computer-Mediated Communication*, vol. 10, no. 4, p. 00, 2006.