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Factors in the emergence and sustainability of self-regulation

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Abstract. We are interested in organizations whose goals do not primarily involve profit, if it even figures at all, but which instead seek to create social capital in a wide variety of forms. Such organizations have widely varying lifetimes, but without an equivalent to accountancy to analyse their state of health and their evolution, it can be hard to establish what brings them about, sustains them or leads to their dissolution.

We report on some preliminary work on the analysis of three such organizations, using three different approaches. Our aim is to see what common factors can be observed, in order to establish the basis for a normative model of organizations, that may then form the core of an agent-based simulation, through which we might explore the sensitivity to and dependencies between the factors.

1 INTRODUCTION

The aim of this project is to develop an understanding of self-regulation from the perspective of the individual and of the community in which s/he participates, and of the extent to which such regulation is or could be mediated by information technology in order to develop, sustain and enhance (digital and physical) communities.

Self-regulation guides our behaviour [4] and the manner with which we interact within a community, such as following shared values, implicit and explicit social norms and behaving in a way that is held to be socially acceptable within the community [3]. Ostrom [8] has shown in great detail how such mechanisms emerge and are sustained in physical resource-constrained communities. On-line communities too are starting to appear (e.g., slashdot, the bazaar model, wikipedia) with similar characteristics. As people continue to move more towards interacting within and integrating virtual communities into their daily lives [5], we believe there is a crucial need to establish an understanding of the self-regulatory properties of communities that can straddle the physical/digital divide e.g.,[1] rather than being constrained to operate in one or the other, as well as the benefits that might arise therefrom. Thus, we propose to examine how – and which – regulation principles and knowledge of self-organising groups translate from physical to digital, and vice versa, and which may not. In order to gain a richer understanding of community mechanisms we examine three unique communities which were identified as fulfilling the criteria of being self-regulating, as outlined below,

and those which utilised varied physical and cyber interaction techniques. In this paper we present the preliminary analyses of the common organizational factors which emerged from our selected communities employing a cross-disciplinary approach. Specifically, we use a systems-based knowledge mapping (SBKM) technique [6] that identifies knowledge types underpinning self-regulating systems in the first case study (Stellenbosch Transition Group). A second approach, applied to the Liftshare scheme, employs survey techniques which aim to provide a preliminary measure of key predictors for individual and group self-regulatory behaviour patterns within the community, such as social roles and attitudes, motivational processes and interpersonal and group processes. The third case study (re-use groups), takes the least formal approach and is the least developed at this stage, being based on discussions with moderators and some very basic statistical analysis of group activities over the last seven years (since 2005), using public data [5].All these groups operate via internet message boards, which are monitored by volunteer moderators.

Our overarching aim is to identify the regulatory mechanisms that have emerged into a normative model of self-sustaining organisations. This will form the basis for future research (see Figure 1). This should then allow for the construction of simple demonstrators with the potential to explore the impact of combinations of different regulation mechanisms and the sensitivity of the key variables. Consequently, we can examine changes in self-regulation and subsequent behaviour via simulation scenarios.

The rest of the paper is organized as follows: in the next section we discuss background and related work; this is followed in Section 3 with a presentation of each case study, the methodology applied, the preliminary analysis arising therefrom and a short discussion summarising the observations in each case. We finish by drawing together the threads of the three case studies, followed by outlining direction for future work in Section 4.

2 BACKGROUND AND RELATED WORK

Self-organising systems are a unique form of social coordination. Such communities are driven primarily by the individuals within, interacting in a way which drives the community towards a shared goal or interest [6]. It is through self-regulation that individuals modulate, modify and monitor their behaviour to attain a given goal [4]. Thus, the self-regulatory processes at the individual and group level should

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[5] A more in-depth analysis is in progress, as a result of gaining access to more comprehensive data.
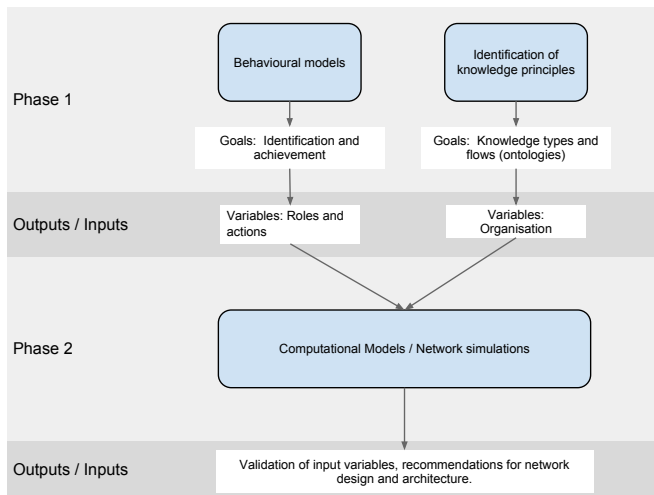
Figure 1. Project outline

dictate the dynamics of a self-organising system. There are several factors which characterise the process of self-regulation and the dynamics of a self-organising system. We drew upon these principles to define a self-regulating community.

Three primary factors of successful self-regulation are *goal setting*, *self-monitoring* and *motivation*. Goal setting refers to identifying a defined goal which initiates self-regulation, and in doing so initiates action to attain that goal [1]. Within a community context, the group must share a common goal(s). Self-monitoring acts as a feedback system, allowing an individual to monitor when it is necessary to adjust an action or behaviour in order to attain ones set goal [8]. At a group level, there must be some type of environment or means to monitor progress on set goals. Lastly, an individual must have the motivation to attain a set goal, without which can lead to the failure to regulate behaviour [3]. Behncke [4] suggests lack of motivation can include trying to attain a non-realistic goal (or one you believe you have already achieved), as well as lack of incentives. Thus, the majority within a self-regulating group should have a motivational investment in the groups shared goals. Whilst there are numerous ways in which failure to self-regulate successfully may occur [2], many essentially equate to either (i) a failure to recognise action is necessary to address a need or a goal, or (ii) an inability to modify / continue appropriate action to attain a goal. It is this recognition of a need or goal by many individuals that brings together self-organising systems for collective action.

2.1 Self-organizing systems

Higher level principles of self-organising systems are also, unsurprisingly, centred around the individuals that make up a system. Lucas [6] defines two factors of self-organising systems that are particularly pertinent to human-based communities; autonomy and importance of interaction. Self-organising groups typical grow in a horizontal, not hierarchical structure [10]. Individuals are brought together through shared ideas or goals, independent of external organisations. As such, a self-regulating group cannot be formed or grow on the basis of the members fulfilling a requirement imposed by a hierarchical system. The group must instead form more organically, out of

a shared need or goal. Similarly, perpetuation or growth of the group would conceivably occur through initiating new goals and/or adapting current goal to continue active participation within the group. The quality of the interaction between individuals within the group is also key for the system to function. Namely, the attainment of goals or outputs in the group cannot be dependent on one person or a small number of individuals actions [6], the group as a whole is needed to achieve a common goal. Otherwise, there is no need for the existence of the group. This highlights the question of how to ascertain what is that small number – or critical mass – by which the vitality of a group might be measured and the chances of it achieving its goals assessed.

2.2 Criteria for self-regulating communities

Using the above principles, we have set out the following criteria as a definition of a self-regulating community:

SRCC1   The group must share a common goal(s) and have the ability to communicate those goals to set them in place.

SRCC2   The group must have the means to monitor progress on set goals. This includes: (i) an effective way to evaluate whether the group is on course in meeting their aims, (ii) the means to communicate when behavioural changes are necessary to obtain set goals, and (iii) to have the knowledge required to choose alternative paths to achieve the goal.

SRCC3   Motivation to attain group goals, for instance, having some incentive in place for being a member of the group and to believe they (as a group) have the tools / ability to achieve set goals.

SRCC4   The group is autonomous. For instance, an individuals membership or involvement in that group is not due to pressure from or in obligation to a manager, institution, funding body, etc.

SRCC5   The attainment of goals or outputs in the group cannot be dependent on one person or a small number of individuals actions.

Using these criteria we selected three unique pre-existing communities as case studies to better understand the common factors in the development and functioning of self-regulating communities.

2.3 Criteria for self-organizing institutions

As noted in the introduction, Ostrom [8] has explored in depth the properties that lead to and sustain human institutions governing physical resource extraction. At this point, it is an open question whether the criteria above and the scenarios below can be captured by an adaptation of Ostrom's principles, which would essentially depend on whether the scenarios can be expressed in terms of resources and whether those resources, centred as they are around social capital and values, have instrinsic properties that make them similar or different from physical resources.

A timely analysis of Ostrom's principles (see Figure 2) is presented in [9], with the aim of showing, through simulation, that they are necessary and sufficient for efficient resource allocation and the sustainability of a single institution, because the individuals and the institution are co-dependent. In particular, if all agents' behaviour is compliant, then principles 1–3 are sufficient, but if not, principles 4–6 are also required to act as a brake on behaviour that could lead to the collapse of the resource and thereby the institution. Principle 7 is

OP1	Clearly defined boundaries: Those who have rights or entitlement to appropriate resources from the CPR are clearly defined, as are its boundaries.
OP2	Congruence between appropriation and provision rules and the state of the prevailing local environment.
OP3	Collective-choice arrangements: In particular, those affected by the operational rules partici- pate in the selection and modification of those rules.
OP4	Monitoring, of both state conditions and appropriator behavior, is by appointed agencies, who are either accountable to the resource appropriators or are appropriators themselves.
OP5	A flexible scale of graduated sanctions for resource appropriators who violate communal rules.
OP6	Access to fast, cheap conflict-resolution mechanisms.
OP7	Existence of and control over their own institutions is not challenged by external authorities.
OP8	Systems of systems: Layered or encapsulated CPRs, with local CPRs at the base level.

Figure 2. Ostrom's Principles for Enduring Institutions (from [9])

taken for granted, while principle 8, which addresses multiple institutions and the relations between then, is left for future work.

While there is no identifiable Common Pool Resource (CPR) – or at least, not yet – in our scenarios, there is a plausible correspondence between the values *behind* Ostrom's principles 1–4, 7 and 8 and the criteria set out in section 2.2, although they are structured relatively differently, having been established independently.

The ability to map the established principles set forth by Ostrom regarding the sustainability of institutions onto our own criteria of self-regulating communities, based on principles of self-and group-regulation, will provide additional insight into both the current understanding of self-regulating communities as well as highlight gaps in our knowledge around new regulatory mechanisms. This is particularly pertinent as these types of institutes/communities shift more and more into a virtual environment. Thus, the possible connections and insight arising from the communities we selected based on our own self-regulating community criteria to that of Ostrom's principles are the subject of current and future work.

3 CASE STUDIES

3.1 The Stellenbosch Transition Group

The Transformation Group of the University of Stellenbosch Business School (USB) was established in 2011, in response to a collective feeling that issues of diversity were under-reported. The group originated from a discussion with the Director of USB about the suppression of conversation about transformation, the ambition to improve the balance of white vs. South African persons of Black, Coloured and Indian ethnicity (BSI) posts and general openness about conversations around this process. After considerable debate a surprising conclusion was reached, namely that the group should not, in fact, be driven from the top of the organisation, but that it would gain more credibility in its conversations if it were seen to emerge from the 'body of the church'. In other words, to be an autonomic entity, which was self-governing and self-establishing. The group started with two members, and provided a discussion events of

a round-table nature to which a minority of new informants/members were added from within USB, differing at each subsequent round table. This medium of discussion has enabled the replication, almost franchising of the transformation conversation. Set in respect of its values and even vocabulary by the original two members has meant that there has been a consistent framing of the transformation agenda. This diffusion of ideology seems to be central to the continuing self-identity of the group.

3.1.1 Methodology and Preliminary Results

The group was invited in late August 2012, to take part in an in focus group based exploration of their work and organisation using a System Dynamics based approach used extensively for strategic definition (and particularly action identification and for knowledge mapping) in organisations. Called Systems-based Knowledge Management (SBKM), it is a straightforward process of identifying causal links in the operation of, in this case, the Transformation Group, so that a model is built up, set by step, of the way in which the group operates (in this case how the transformation conversation becomes more open). There were six members present, including the two original members. This group constituted the most active, central core of the group's participants.

The results of applying the SKBM approach are shown in Figure 3, where solid links (blue and green) denote positive influences and dotted (red) are negative. The blue and red links were identifed by the group in discussion, while the green links were added as a result of post-hoc analysis and subsequently confirmed by the group and in effect have the same status as the blue links. The figure present here follows the deletion of nodes without inward and outward links, since these cannot contribute to the closed cycles of causality, whose discovery is the point of the exercise. Many of the loops present in the model are effectively duplicates, but there are 12 distinct and significant loops present, which together lead to the identification of seven key knowledge types, seen as the properties needed for this group to function and self-organise. Specifically, knowledge of:

KT1 **Qualities of autonomy:** Knowledge and recognition of the need to operate outside the structure, processes and politics of formal control.

KT2 **Energy, voice and continued freedom:** Knowing how to generate momentum within the membership via open and emotional conversation (where participants can disagree).

KT3 **Creation of coherence:** Knowing how to create coherence as a result of open, participative conversation (where agreement is reached)

KT4 **Growth dynamics:** Knowing how to balance size and inclusivity/growth.

KT5 **Continuity – Importance of linking past and future:** Knowing how to establish initiation processes wherein which each member shares their own resources and feels a sense of ownership/belonging to the group.

KT6 **Clarity of purpose:** Knowing how to structure a clear action agenda which facilitates momentum and growth.

KT7 **Heterogeneity and homogeneity:** Knowing when and how to increase heterogeneity in the group in order to secure growth.

A complete presentation of the loops and the knowledge types would take more space that is presently available, so we focus on the extraction of the loops supporting KT2 as an example (Figure 4).

Examining loop 2, in detail, we can see it contains three integrated loops with common elements. All are concerned with the dynamics
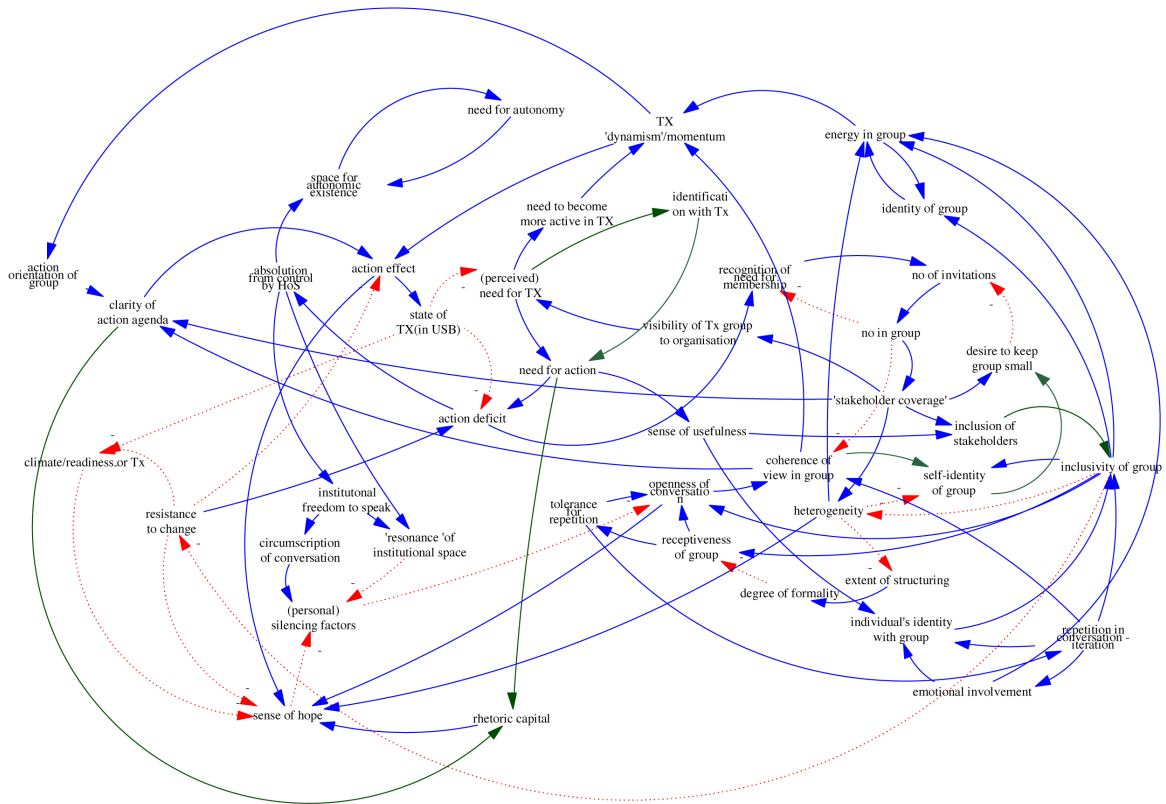
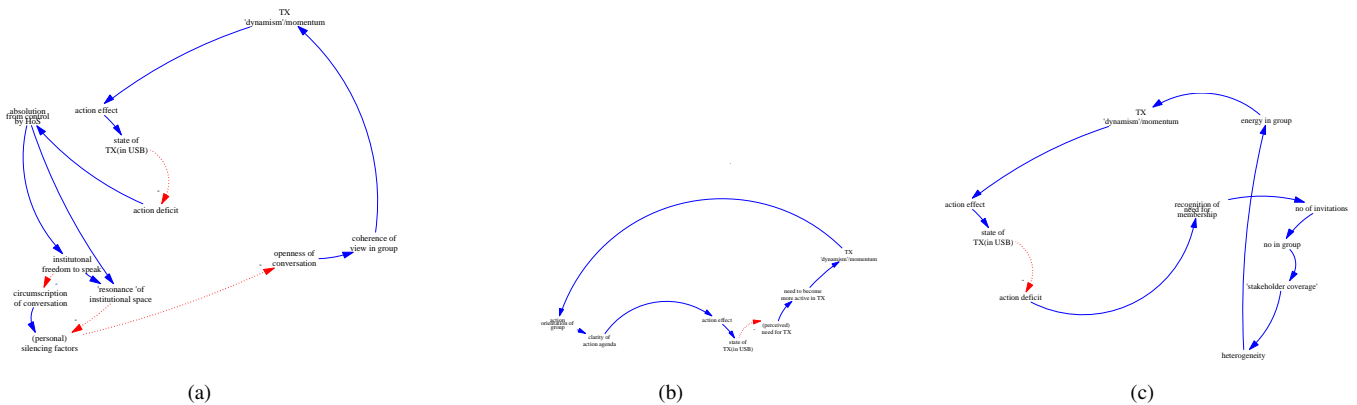**Figure 3.** Result of the Systems-Based Knowledge Mapping process

Figure 4. Loops 2, 3, 4 (a) 11 (b), and 12 (c), corresponding to KT2

of the 'momentum' of the group, that is, its sense of forward movement and success. As the group achieves momentum (another word used was 'traction') this has an effect, in that the conversation which it seeks to engender improves in spread and richness. This (says the group) then improves the state of transformation in USB, primarily because the surfacing of transformation issues itself improves the way in which previously disadvantaged colleagues are treated. It is a tenet of transformation studies that making the privileged aware of

the coercive nature of their privilege is itself a step towards avoiding that coercion.

This inherently-owned action effect then reduces the need for action, (action deficit). Interestingly, the absolution of control by the Head of School, deriving as it does from the need for action, is thereby reduced (i.e. as the need for action is reduced, the need for autonomy of the Transformation Group also reduces). Counter-intuitive as this is, it can be observed in the level of autonomy of

the group as the transformation conversation becomes freer in the School.

The loop then divides into three paths. Loop 02 passes through institutional freedom to speak, circumscription of conversation to personal silencing factors. What is being tacitly observed by the group is that as the autonomy of the group changes (in the sense of its freedom from Head of School influence), its ability to erode the circumscription of conversation alters; a more autonomous group sees less circumscription and reduces the personal silencing factors in the School.

3.2 Liftshare

Liftshare.com is a community that straddles the physical/digital divide in that members interact in both on-line and off-line environments. Established in 1997, Liftshare currently has over 350,000 registered members. The Liftshare network enables individuals to find other people in their area to car-share, (either as a driver or as a passenger) using on-line messaging to coordinate the process. Once individuals find a car-share partner(s), they then meet in the physical world and travel together to a shared destination. Thus, the group's primary common goal is to organise and complete a shared journey successfully with other Liftshare users. The community is completely self-sustained by the members of Liftshare, and as such presents an interesting self- and group-regulation dynamic that meets our criteria for self-regulating communities.

3.2.1 Methodology and Preliminary Results

Twenty-four liftshare users (9 males, 15 females; age M = 32.08, SD = 10.02) completed a survey that was comprised of four discrete sections specifically regarding the respondents' involvement with Liftshare. In the survey, group members were asked about: (i) the role they play in the community and their actions toward achievement of a successful liftshare, (ii) goal monitoring and goal achievement, and (iii) self- and group related- regulation processes. Self- and group-regulation was measured using three psychometric scales: the Bridging Social Capital scale [11], which indicated the extent to which respondents feel the liftshare community promotes contact with a broad range of people, view themselves as a part of the broader group and diffuse reciprocity within the community. Perceived Organisational Support and Reciprocation Wariness scales [7] assesses the extent to which liftshare users perceive that the community values their contributions and cares about their well-being, and the extent to which users may be hesitant to accept or extend help as well as concerns over exploitation, respectively.

Role and actions: a Liftshare user can take one of three roles: (i) they can seek lifts from others, (ii) offer lifts to others, or (iii) both seek and offer lifts. Each role offers a different commodity to the community. Those seeking lifts do not have a car to offer as a resource to the group, but they are expected to help their fellow liftsharer pay for petrol. Conversely, those that offer lifts do not rely on the community to get to a destination (as they have a car), but the community improves their travel experience. As one user stated, "*It [Liftshare] has saved me a fortune and introduced me to some great people*". Those that both seek and offer lifts can be seen as a more versatile member of the group and potentially benefitting the most out of being a member of the community. They are able both to offer the resource of a car and are willing to share a journey with another resource-holding member. Examination of the mean ages of Liftshare

users by role using analysis of variance also revealed that those in the role of both offering and seeking lifts are marginally older (M = 36.2 years) than their lifts offering (M = 35.2 years) and lift seeking (M = 25.8 years) counterparts, F (2,18) = 3.48, $p = .05$.

We explored the actions that members take towards the achievement of a shared journey by examining the scope of interaction that they have with the community. This included the number of journeys that they made in the last 6 months, and the number of travel partners that they typically interact with. Preliminary results showed that the role a member plays did not statistically differ in terms of the scope of interaction they have with the community. However, heavy users of Liftshare (e.g. 15+ journeys made) tend to travel with the same person, or same 2-3 people within the community, whereas less frequent users tend to have a higher number of different travel partners, r = -0.53, $p < .01$. This may suggest the formation of pockets within the community around those who interact with the Liftshare community more frequently. However, this may pose a problem for growth dynamics within the community, as one member stated, "*I havent found it [liftshare] that useful as most people I contacted were already in a liftshare and werent looking for anyone else*".

Goal monitoring and goal achievement: in order to organise and complete a shared journey, effective communication is needed to monitor that goal. The Liftshare community utilises an online messaging system that allows users to post journeys they will be making as well as the role they play in that journey (seek, offer or both seek and offer lifts). Liftshare members can then search all journeys posted within the community and contact other individuals via private message to arrange a liftshare. Survey respondents rated the effectiveness of this system as 'average' overall. However, 75% stated they had never experienced a miscommunication or missed journey once a liftshare had been agreed upon. Furthermore, members that rated the messaging system as being most effective were related to reporting that Liftshare had substantially improved their travel or commute (r = 0.47, $p = .02$). This suggests the ability to monitor the organisation of a liftshare journey through effective communication may lead to a positive experience of Liftshare.com and achieving a member's primary goal of successfully sharing a journey. In addition, there was a trend indicating heavy users of Liftshare (15+ journeys made in the last 6 months), and those who travel with the same person or same 2-3 people in the community reported the greatest belief of achieving the goal of improved travel through their being a member of the Liftshare community (F(2,21) = 3.08, $p = .07$ and r = 0.49, $p = .08$, respectively).

The community also has five secondary goals which are made prominent on their website (liftshare.com). Each are related to successful journey sharing: saving money, having company, travel convenience, reducing pollution and improving traffic congestion. Survey respondents were asked to rank these goals from 1 (most important), to 5 (least important), as they relate to them as a member of Liftshare. Analysis showed a significant linear effect, F (1, 21) = 28.77, $p < .01$, suggesting that saving money was ranked as being the most important (M = 1.50) to members, significantly differing in importance to reducing pollution (M = 2.92), convenience (M = 3.17), improving traffic congestion (M = 3.25), and having company (M = 3.33). The ranking of goals did not differ by the members role in the community, F (2, 21) = 1.05, $p = .36$ (n.s). Notably, the most important goal (saving money) is a relatively individualistic goal or incentive for being a part of the Liftshare community, whereas the second most important goal (reducing pollution) is collectivist in nature. This may suggest a self-organising community needs a variety

of goal incentives, both personal and communal, to motivate the majority of the group population. This possibility is further supported in our preliminary results in examining differences in self- and group-regulation processes.

Self- and group-regulation processes: individual differences in bridging social capital – an indicator of members' feeling that the Liftshare community promotes interaction with diverse people, a sense of community and diffuse reciprocity – suggested that different goal incentives vary in importance for different members. Those members who felt more strongly about the importance of social capital tended to rank saving money as a less important goal (r = .38, p = .06), instead tending to rank having company on a journey (r = -0.51, p = .01), and the convenience of sharing a lift (r = -0.39, p = .05) as being more important goal incentives of being a member of Liftshare. In addition, members that reported feeling greater organisational support from the Liftshare community, such that they perceived the community valued their contributions and cared about their well-being, also tended to believe that their involvement in Liftshare improved their travel/commute (r = 0.49, p = .02).

Respondents reported relatively low levels of feeling apprehensive / being uncomfortable (M = 2.33) about sharing a journey with someone they met through Liftshare.com (1-5 scale, 1 indicating low levels and 5 indicating high levels). However, those who reported higher levels of apprehension/discomfort journey tended to have higher levels or reciprocity wariness, (r = 0.54, p = .01). Thus, members in the community that are generally hesitant to accept or extend help maybe less comfortable in the actions necessary to attain this community's common goal.

3.2.2 Discussion

In summary, several themes have emerged so far regarding roles, actions and regulatory processes within the Liftshare self-regulating community:

1. The role an individual fulfils is dictated by the different resources that they provide to the community (e.g. a car, helping to pay travel costs etc). Higher value resources (e.g. a car) tended to be provided by older members of the community.
2. Members who frequently interact with other members in the community tend to form smaller group links (e.g. always sharing a journey with the same person(s). Members who interact less frequently with the community tend to come in contact with a broader spectrum of other community members. There are potential issues here for growth of the community.
3. The current Liftshare communication system of journeys available and private messaging has room for improvement. Members who were able to efficiently communicate perceived themselves to be more successful in their ability to travel.
4. Both individualist and collectivist goals may be necessary incentives to motivate a diverse community.
5. Differences in member need for social capital and community support may influence the importance of goals, incentives, and actions put in place to achieve the communitys common goal(s).

3.3 Freecycle/Freegle: re-use groups

There are numerous local and internet-based groups that exist to try to encourage re-use in place of sending items to landfill. We focus here on Freecycle [6] and Freegle [7]. Freecycle started in Arizona in 2003 and established itself in the UK in the same year. The UK activity has since split, with about 60% of UK groups now operating under Freegle, a UK registered charity, and the remainder being administrated by the international Freecycle organization.

3.3.1 Methodology and Preliminary Results

We noted in the introduction that the approach taken to the examination of this group is less principled and less scientific in what has taken place to date. The primary sources of data have been the Freecycle and Freegle websites from which data about country presence, number of groups, group sizes and message volumes hae been taken. These metrics form the basis for a preliminary analysis of the vitality of a group. There is also anecdotal evidence from group moderators regarding the creation of new groups. There are some role similarities with the liftshare scenario, in that individuals can: 1. seek goods 2. offer goods 3. seek and offer goods. It would appear that in practice, many people are sinks or sources of goods, but that relatively fewer are both. As with Liftshare, there are both individual and collective incentives: to save money and to reduce landfill. Other factors, no doubt, also play a part, but need surveys for appropriate identification.

Out of the 370+ UK groups ($\approx$1.5M members), we have selected 10 groups at random that started in 2005 and that have a current membership of more than 10,000. As can be seen from the difference between total messages and average messages (Figure 5), size is not always correlated with activity. What is also interesting is that activity seems to peak in 2008-2009 and has been declining, but lately quite slowly, since then. Since all we have is message counts, we can only hypothesize about the reasons behind this fall. One possibility is that activity tracks, with some lag, the state of the economy. It might be expected that freecycling might increase in an economic downturn, but although more people will seek goods in lieu of paying for them, at the same time fewer people will offer goods – making do with what they have rather than replacing. In consequence, overall message counts drop. There may also be a technological explanation: (at present) the only data we can obtain relates to Yahoo-hosted Freegle groups, but the last two years have seen the migration to Freegle's own hosting service and the addition of two new channels in the form of Facebook and Twitter. Anecdotal evidence is that membership increases are observed when these channels are added to a given group and that message volume also rises[8].

3.3.2 Discussion

It was noted above that internet mediated re-cycling of unwanted goods started in 2003. Although there are claimed to be $\approx$5,000 groups worldwide across $\approx$100 countries, the main metrics (age, size, activity) are highest in the US, the UK and other Anglo-Saxon countries (NZ, AU). Indeed, groups in other countries appear often to be centred around Anglo-Saxon communities. Thus we posit another factor that may influence the sustainability of a self-regulating community: the cultural situation – or at least, how the goals of the group and the associated incentives align or not with the cultural values of its situation.

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[6] `http://www.freecycle.org`, retrieved 20130209.
[7] `http://www.freegle.org.uk/`, retrieved 20130209
[8] We are currently seeking access to the data for these channels in order to extend the analysis.
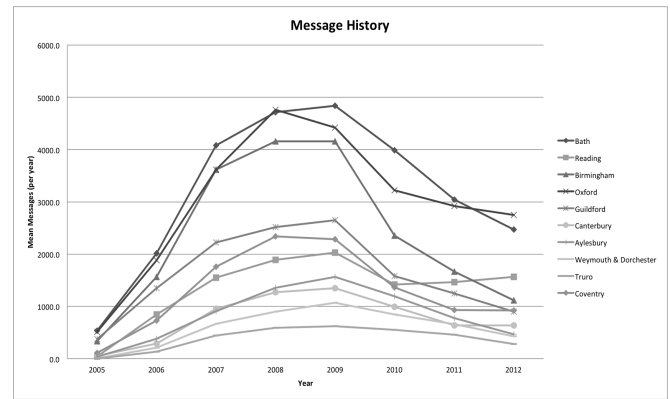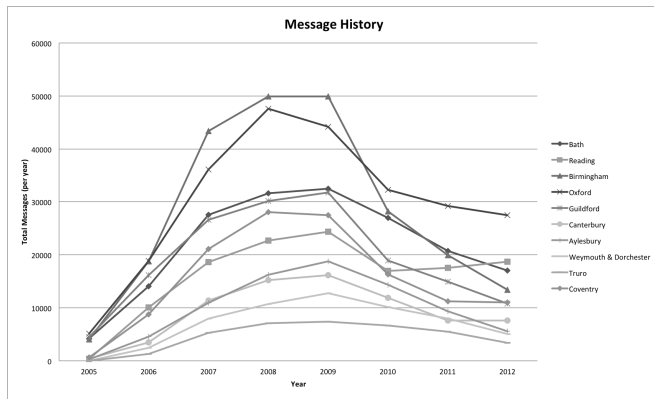
Figure 5. Total and average message counts for a selection of UK Freegle groups with a current (2013) membership $> 10K$

4 DISCUSSION AND FUTURE WORK

In line with our aim of achieving a better understanding of the common factors in the development and functioning of self-regulating communities across the physical/digital divide, the three reported case studies yielded five primary regulatory mechanisms from which we can begin to move forward in outlining a normative model of self-sustaining organisations. We summarize our observations about each of these as follows:

1. Firstly, there are distinct roles for members, which do have the ability to overlap (e.g. seek and offer lifts or goods). The current preliminary data suggests available resources of individual members may at least partially drive the role they take in the community. This factor is in line with SBKM finding which suggest knowledge of when and how to increase heterogeneity can secure growth. It remains unclear, however, what forces may trigger the need to increase heterogeneity within roles. Further research is needed to address both this and to identify the critical mass not only for the group as a whole, but fulfilment of distinct vs. overlapping roles in a community's ability to sustain and grow.

2. Second, the ability to balance the size and inclusivity/growth of a community (KT4) must be considered. Our data suggests members who frequently interact in the community may start to form smaller, exclusive, groups which in term may result in decreased growth.

3. Third, members who perceive they have the ability to communicate adequately with other group members appear to believe the community facilitates the achievement of a common goal. The ability for communication channels to evolve and adapt seem to increase community vitality. This is in line with the SBKM findings, that tools or people within the group much be able to create coherence as a result of open, participative conversation (KT3).

4. Fourth, members need both individual and collective incentives to maintain activity/vitality of the group. It is possible the individualist incentives facilitate early action from the members, as these tend to be achieved in the short term (e.g. save money), whereas collectivist incentives may act as a long term motivators for more abstract goals (e.g. reducing landfill waste, reducing pollution). These longer term motivators will hold different weight with different individuals within the group, such as those who tend to perceive value in social capital, or have different needs in their sense of ownership to the group (KT5).

5. Fifth, although self-regulating communities are autonomous, the influence of outside sources must be considered. Particularly in communities which straddle the physical/cyber divide, members of cyber communities typically participate in any number of cyber and physical communities. Economic climate and cultural situation needs to be considered, especially considering the possibility that individual circumstances within a given community could vary widely in these two respects. It is possible that the knowledge to structure a clear action agenda to facilitate momentum within the group (KT6) may allow the community to minimise the effects of exogenous influences.

We believe that the next steps in this line of research need to incorporate insights from these and further case studies on the mechanistic factors that allow self-regulating communities to sustain and grow. One potential avenue is to employ the currently reported themes, in tandem with Ostrom's principles and the self-organising criteria identified here into the generation of an ad-hoc / peer-to-peer networking model, where the survival and growth of the network is dependent upon the effective / sustained sharing of (computing) resources (storage, processing etc). Through simulation of such a network, we would hope to refine further the impact of the mechanisms so far identified, while also providing the means to rapidly evaluate other mechanisms that emerge from our continued research in this area.

The ability to rapidly add and evaluate self-regulatory mechanism in a simulation scenario will provide insight into a community's ability to change key principles [8] such as, boundaries, resource allocation, selection and modification of rules, and shifts in external authority challenges, without detrimental social effects on the development and sustainment of that community.

The above are only a few of the questions that need to be addressed in order to refine our understanding of self-organising systems. We believe the potential for this area of research for both social and computer scientist will incite an in-depth and lively discussion.

ACKNOWLEDGEMENTS

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