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The Role Of VGI And PGI In Supporting Outdoor Activities

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ABSTRACT: This paper explored the question of how *volunteered* and *professional* geographic information (VGI and PGI) can be used together in an outdoor recreation context. In particular, consideration is given to what makes each information source valuable to the user, and how this can be used to help developers of GIS provide more useful, usable and satisfying products. The assumption that VGI is inferior to PGI is shown to be unfounded; rather each has its own strengths in describing particular aspects of the user information landscape. Considering the opportunities to influence user activities, both VGI and PGI have a greater ability to influence the user in the planning phase than actually during the activity. The importance of the author of the information (volunteer or professional) is shown to be of less importance to the end-user than the characteristics which describe the information in terms of communication, frequency of updates and accessibility.

KEYWORDS: VGI; Human Factors; Relevance; Information Use; Kayaking

1 Introduction

Volunteered Geographic Information or VGI (Goodchild, 2007a) has demonstrated potential to enrich the user experience of products which utilise geo-information, including enhancing credibility (Flanagin and Metzger, 2008), increasing spatial accuracy (Goodchild, 2008) and the collection and distribution of VGI through mobile devices (Sun and Song, 2009). Additionally Coote and Rackham (2008) and Haklay et al. (2008) have demonstrated that while the levels of data richness which VGI may achieve is still undefined, there is a great potential for added benefit to the user. Yet despite these advances the question still remains as to how VGI can be used by end users alongside or instead of *Professional Geographic Information* (PGI); or alternatively, is VGI an interesting but largely irrelevant phenomenon when it comes to producing highly usable *specialist* geographic information? This is essentially a human factors issue related to the *perception and use* of information, rather than a computer science or GIS issue related to information *provision*.

In appraising the synergistic relation between people and place in the "age of web 2.0", Hardey (2007) commented that user-generated geo-located information (i.e. VGI) is one of the driving forces behind the revolution in experiencing the world around us. This is in contrast to the traditional view

that GI is the *exclusive* preserve of the professional (Crone, 1968). The comment by Hardey (2007) also highlights one of the fundamental issues in the academic treatment of VGI, being the lack of agreed terminology to describe the set of neogeographic phenomenon relative to occurrences in the *real world* (Crampton, 2008). One of the key contributions of this paper therefore is to help develop and define the boundaries of VGI and PGI within an information search and risk management context.

The concept of using information generated and moderated by amateur volunteers has not been without criticism, as demonstrated by the comments of Keen (2007) who remarked that “*instead of a dictatorship of experts, we’ll have a dictatorship of idiots*”. The assumption that volunteered information is inferior to professional information, because of the credentials of the author of that information, has been suggested as a concern amongst those considering utilising VGI within professional or commercial systems (Parker et al., 2010). This may stem from the professional developer’s uncertainty as to the level of trust the end user may place in VGI if it is used within their products, and what happens if that information is wrong.

To date the majority of research into the use of VGI has focused on the delivery of information through mobile, Global Positioning System (GPS) enabled devices; i.e. real-time access and use (Sun and Song, 2009). Other recent research has aimed to determine the level of user trust in VGI by comparing it to PGI sources (Bishr and Janowicz, 2010; Haklay et al., 2010). Largely, these research approaches have aimed to understand the issue of demonstrable quality within VGI, an area highlighted by Mummidi and Krumm (2008) as being a salient problem with VGI. This however does not address the differences in human perception of VGI and PGI relative to its use within specified contexts. Additionally while research has suggested that VGI may be used alongside PGI, there has been little detailed, task-based analysis of the role that VGI might play in this respect, and its potential advantages and disadvantages to an end user.

This paper investigates how VGI and PGI may offer different benefits to an individual engaging in leisure activities relying on information access, taking advantage of the differing characteristics of these information. Focuses is also given to the user perceived *value* (the consumer’s overall assessment of the utility of a product based on perceptions of what is received and given) than *quality* (the extent to which the product or service satisfies the technical or specific needs of an individual or organisation) due to the research focus on qualitative opinions rather than quantitative relationship; both defined by Zeithaml (1988).

It is the intention that this article may produce a greater understanding of effective use of VGI alongside PGI in the design of consumer orientated applications products and services. Therefore the aims of this paper are to explore:

- How VGI and PGI offer different benefits to the end user in a real world scenario;
- The strengths and weaknesses of VGI and PGI relative to how they meet the information requirements of the user’s tasks and activities;
- How VGI and PGI may be effectively integrated to produce highly usable and effective applications.

The overall concern of this article is the support that information provides for end users undertaking a specific task. Consequently, focus is not given to investigating the aspects of technical spatial data frameworks, although it is assumed that platforms such as *OS OpenSpace* (Ordnance Survey, 2010) and *Open Layers* (OSGeo, 2010) may have considerable potential for enabling such integration. In order to investigate effective information use, a user group was required which already makes critical use of both VGI and PGI. The broad category of *Outdoor Adventure Recreation* was selected for the focus of this study due to the key role of geographic information (GI) within these activities. Importantly, outdoor adventure activities exhibit a relatively high potential for personal risk due to uncertainty and temporal variation in the conditions of the environment in which they participate (Ewert and Hollenhorst, 1989). It was assumed that this relatively high level of uncertainty relating to environmental conditions (and the potentially serious consequences) would shape the accessing and

use of information, and would encourage the participants to critically use a wide variety of information sources while being open to new innovations where beneficial to them (Richins and Bloch, 1986).

Kayakers were selected as the participant community for this study due to their existing reliance on GI, use of dynamic information (e.g. river levels), dependence on multiple and varied information sources, range of potential experience levels and the potential of VGI to have influence on activities alongside PGI. Additionally while their sporting skills are specialist, their use of GI is an extension of those skills employed within normal/ non-professional information searches, making the outcome of this research scalable to the larger issues of how VGI may add benefit over and above PGI in other use contexts (Zeller, 2009).

2 Theoretical background

Within a recreational context, individuals require information in order to find potential opportunities for experiences, and to find further sources of information (Schuett, 1993). Estes and Mooneyhan (1994) commented that despite the long history of information collection, standardisation, processing, storage and dissemination, PGI cannot produce sufficient data to cover every conceivable user need. Goodchild (2007b) proposed VGI as a potential solution to this problem and went on to suggest the worlds' six billion inhabitants as potentially untrained GI contributors. Goodchild (2008) later commented that "*perhaps the most significant area of geospatial data qualities for VGI is currency, or the degree to which the database is up-to-date*".

To analyse the impact of information within a task-related context, theoretical consideration must be given to *Information Search* by the end user, categorised by Hawkins et al. (1995) as *internal* (accessed from the user's personal experience) and *external* search behaviours (the search process from external stimuli relevant to solving the problem). The importance of personal experience is highlighted by Manfredo (1989) who commented that individuals seeking information about recreation experiences are influenced by their past knowledge, interest and attitudes. Consequently, the use of internal (personal experience) / external (VGI and PGI) information sources may be seen as fundamental differences in the information-seeking behaviours of individuals within a task context.

The user's assessment of information *relevance* has been highlighted as the central theme in the users' selection of one information source over another (Barry and Schamber, 1998). This theory provides a framework for evaluating information that is accessed during an information search, since evaluation in-situ (i.e. an outcome-based measure) is not possible until the actual activity is undertaken. In categorising the criteria for *relevance*, Barry and Schamber (1998) stated that relevance may be understood in terms of:

- Accessibility - Some effort is required to obtain information
- Accuracy/validity - Information is accurate, correct or valid
- Affectiveness - An emotional response to information or sources of information
- Availability of Information - Information or sources of information are available
- Clarity - Information is presented in a clear and well-organized manner
- Currency - Information is current, recent, timely, up-to-date
- Depth/ Scope/ Specificity - Information is in-depth or focused
- Quality - General or specific qualities assumed based on the source providing the information
- Tangibility - Information relates to real, tangible issues

- *Verification* - Information is consistent with or supported by other information within the field

Additionally, information sources which potential users either consciously or subconsciously access can be categorised as *formal* and *informal* sources (Hawkins et al., 1995). Here, *formal* sources include printed media, destination-specific literature, broadcast media and discussions with professionals, whilst *informal* sources include family, friends and other users (Gitelson and Crompton, 1983). It is important to note that informal sources may be as important as, or more important than, formal sources.

3 Method

3.1 Choice of Methodology

During this study a qualitative *multi-method* approach was used to maximise the validity and insight associated with the study. Three main forms of data collection were used: participatory observation, detailed focus groups and diary studies, followed by domain expert validity checking of initial results.

3.2 Participant sampling strategy

Non-probability purposive sampling was used to identify participants from a diverse range of kayaking clubs. The specific selection criteria for participant selection were:

- A minimum of two years kayaking experience
- Familiarity in planning of kayaking trips
- Experience using professional and volunteer information sources

In all, 32 participants (23 highly experienced, nine intermediate) from four separate kayaking clubs took part in the 12 focus groups, and 50+ club members were involved anonymously in participatory observation. Although clubs had their own distinct focus (racing, white water, sea, social, flat water), all four were basically recreational clubs that organised trips for their members, to familiar and unfamiliar locations.

3.3 Data collection

3.3.1 Focus groups

Focus groups were used to gather rich understandings of participants' experiences and beliefs (Morgan, 1998). Lead questions were derived and presented as topics for spontaneous and wide ranging data gathering sessions (Krueger, 1998). Focus group sessions focused on kayaking trips to unfamiliar locations, as Gitelson and Crompton (1983) demonstrated that individuals looking for new locations are more likely to undergo a thorough and detailed information search process. In addition, trips to unfamiliar locations present a higher level of risk to personal safety, and therefore placed concomitant demands on the effectiveness of any information search process, and the ability of information accessed to meet the needs of the user. All focus groups were transcribed in full and thematically analysed using NVivo 9 (QSR International, 2010).

3.3.2 Participatory observation

Participatory observation from the position of *Participant As Observer* (Gold, 1969) was undertaken to better understand the culture and perspectives of the participants, and the context in which information is used. This data collection involved taking part in weekly meetings, indoor pool training sessions and river trips. While no notes were taken during investigation due to full participation in the kayaking activities, observations were formally recorded post participation using the framework of *Space, Actors, Activities, Objects, Acts, Events, Time, Goals* and *Feelings* (Spradley, 1980). These notes were used to corroborate findings from the focus groups during analysis of the data.

Participatory observation occurred in 12 instances with independent canoe clubs, canoe clubs

involved with focus groups, indoor pool training sessions and river trips. Figure 1 below presents a series of geographic features which participants made reference to during the kayak trip as being influential on their perception of the terrain.



Figure 1. Information sources used by kayakers observed during participation

3.3.3 Diary studies

Prior to the river trips attended through participatory observation the organisers were provided with diaries to record their information search habits. These captured the information search requirement, solution and effectiveness of the search. In total four diaries were completed by highly experienced kayakers, providing additional depth and insight into information use during the participated observations.

3.4 Thematic analysis

Thematic analysis was selected due to its focus on identifying themes and patterns in participant behaviour, and the development of deep insights in phenomena from which hypothesis and/or theory may be generated (Taylor and Bogdan, 1984). From the work of Boyatzis (1998), the following thematic analysis principles were followed:

1. *Developing Themes and Codes* - Combine and catalogue related patterns into sub-themes, producing a comprehensive story of their collective experience.
2. *Sensing Themes* - Patterns of Experience are collected from the data, recognising a code-able moment.
3. *Consistent and Reliable Coding* - Identify all data that relate to already classified patterns.
4. *Review of Codes* – allow for the coding structure to change with themes emerging from the data.
5. *Testing Reliability and Interpreting The Information* - Build a valid argument for choosing themes and formulate ‘theme statements’ to develop a ‘story line’. “*When the literature is interwoven with the findings, the story that the interviewer constructs is one that stands with merit*”.

In order to understand the deeper qualitative perspectives of users, thematic analysis was used to identify and categorise salient themes to describe the underlying user perceptions (Robson, 2002). Since Boyatzis (1998) remarked that “*converting themes into codes and then counting presence, frequency or intensity does not in and of itself create a link between qualitative and quantitative methods*”, numerical outcomes from the querying of the data were not be taken as hard fact, but rather an expression of frequency. These frequencies were used in It is during the third stage of the planning process (A3), where internal information is of less use to the end-user, and external information in the form of VGI and PGI becomes the most relevant. Here, both VGI and PGI are used equally by the end user. During observation sessions, participants discussing trips which had previously planned made regular reference to *finding out information* [from external sources] before fixing on their plans for trips.

When moving onto the fourth planning stage (booking amenities - A4) PGI becomes the predominant source of information, with VGI playing a lesser role. Whilst actually undertaking the trip (B0), there is little or no direct use of either VGI or PGI sources. Instead internal information becomes of higher utility to the participants, used to interpret the markers and features on the water (Figure 1) in order to successfully and safely navigate the rapids on the river with a high degree of personal enjoyment. During the post-trip activities (C0), the focus is on information sharing, rather than information access; see Figure 5. Consequently, external information sources only have the opportunity to have impact on the activities within the data gathering section of the trip (A3 - A4).

As demonstrated in Figure 2, three tasks dominate the trip activities; *planning the trip* (A0), *undertaking the trip* (B0) and *post-trip discussion and sharing of experiences* (C0). Using this outcome, the results of the thematic analysis were categorised relative to the different phases within the overall task. This is presented within Figure 3 (below), with the height of each column representing the number of references made to each of the emergent themes.

4 Results and Analysis

4.1 Impact of information on trip activities

In order to contextualise the impact of VGI and PGI across the entire the trip process, a Hierarchical Task Analysis (HTA) was performed based on the focus group transcripts and experience gained during participatory observation. The HTA was required in order to identify which activities are more likely to draw on external information sources (as opposed to personal experience), and to provide a framework for understanding the relative roles and influence of VGI and PGI.

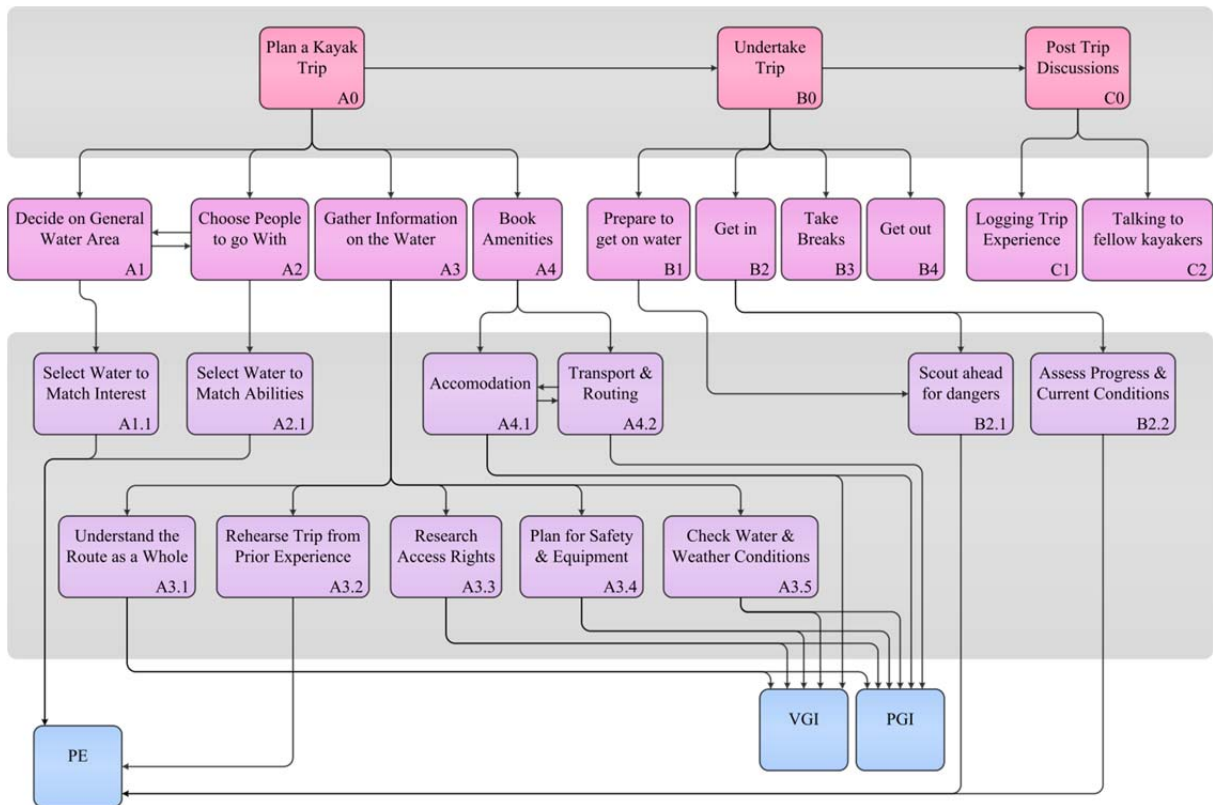


Figure 2. A hierarchical task analysis of a kayaking trip

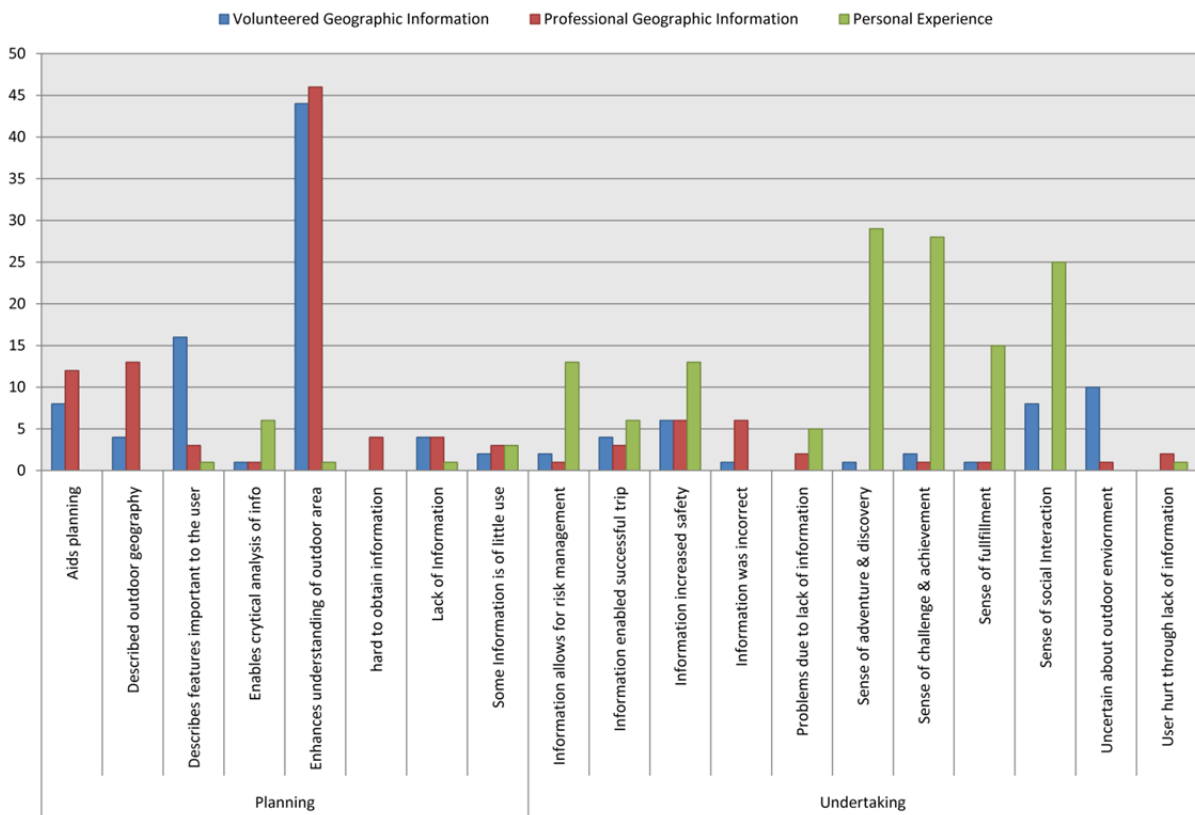


Figure 3. Impact of information on outcomes; number of references made by participants.

As shown by the HTA (Figure 2) and Figure 3 (above), in the earliest stages of the kayaking activity

(A1 – A2), *internal information* in the form of personal experience is the predominant information source. This is mirrored by the participatory observations made during the trip. Figure 1 shows the water levels at the get in point, an *official* water measure and a prominent bridge. Participants made frequent reference to features such as these in their assessment of the river conditions and how the water course should be navigated. While such measures may be categorised as *official*, it was the participants’ internal knowledge and experience which gave those features meaning rather than information acquired prior to the trip.

Although there was limited explicit mention of post trip activities, the salience of volunteered information during the trip planning stage suggests that dissemination and volunteering of information post trip to other kayakers is a key element of the trip activities:

By chatting to paddling friends I usually can decide whether the particular river is within my comfort zone and abilities [#2-2-04].

During all stages of participatory observation, sharing of *internal information* and discovery of *external information* through an active information searches was a constant feature, yet was never highlighted as a crucial step by the participants. This is despite the *zeitgeist of information* solutions created by the internal and external information search and share activities.

The diary studies provided additional insight into the information search behaviours of trip organisers. Figure 4 presents the number of formal and informal sources used during the planning phase of the trip by these participants.

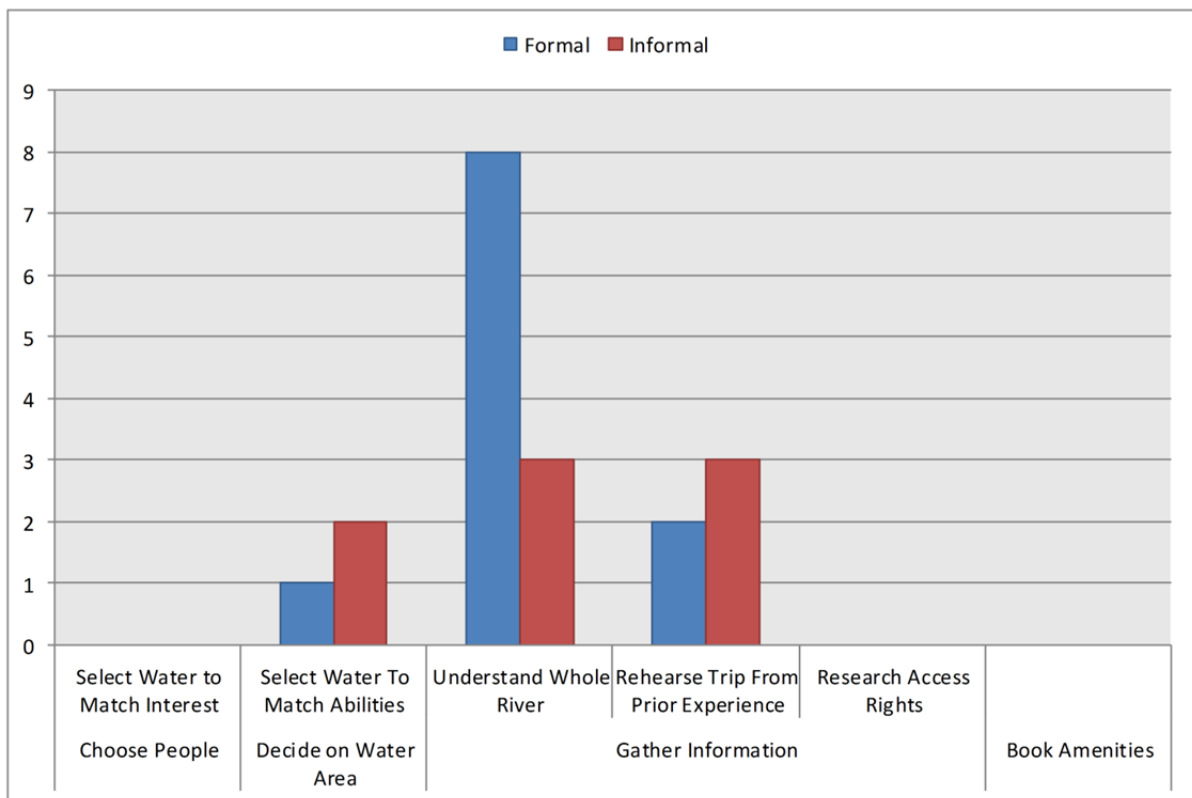


Figure 4. Formality of Sources Accessed During Trip Planning; Number of References Made by Participants.

4.2 Relevance of information sources

The results of the thematic analysis were coded and analysed in relation to the theoretical framework of Barry and Schamber (1998). This enables a clear comparison of the differences (or more strictly

speaking the *perceived* differences) between VGI and PGI. The numbers of references made on the themes of relevance are presented in Table 1.

Table 1. Relevance characteristics of VGI, PGI and personal experiences – coding references

| Relevance Theme | Sub Category | Themes From Data | VGI | PGI | Personal Experience |
|-----------------------------|--------------|------------------------------------|-----|-----|---------------------|
| Accessibility | Negative | Costs money to acquire | 0 | 6 | 0 |
| | Positive | Easy to access | 3 | 4 | 0 |
| | | Free to get hold of | 5 | 0 | 0 |
| Accuracy | Positive | Accurate | 15 | 5 | 0 |
| | | Less biased | 1 | 0 | 0 |
| Affectiveness | Negative | unfriendly sources | 6 | 0 | 0 |
| | | Friendly sources | 5 | 0 | 0 |
| Availability of Information | Positive | Large volume of info available | 3 | 0 | 0 |
| Clarity | Negative | Sometimes Vague | 1 | 12 | 0 |
| | Positive | Well structured | 0 | 8 | 0 |
| Currency | Negative | Out of date | 4 | 30 | 0 |
| | Positive | Up to date | 23 | 2 | 0 |
| Depth, Scope, Specificity | Negative | Incomplete | 8 | 22 | 1 |
| | Positive | multiple sources converge on truth | 11 | 8 | 0 |
| | | Unique Information | 2 | 1 | 0 |
| Quality of Sources | Negative | Opinionated | 26 | 22 | 0 |
| | | Purposeful Misinformation | 8 | 0 | 0 |
| | | Unreliable or incorrect | 18 | 5 | 0 |
| | Positive | Reliable | 28 | 33 | 0 |
| | | Trust personal contacts the most | 18 | 0 | 3 |
| Tangibility | | High Tangibility | 14 | 9 | 0 |
| | | Low Tangibility | 44 | 40 | 2 |
| Verification | Negative | not as good as experience | 1 | 1 | 3 |
| | Positive | The best form of information | 4 | 0 | 2 |

During the focus groups 53% of the participants stated that *professional information* tends to be out of date:

What maps and guidebooks don't give you is up to date information. Just because it was a good guide to the river five years ago doesn't mean it's a good guide to the river now [#2-1-05].

In contrast only 13% of participants commented that *VGI* was out of date. This is corroborated by 50% of the participants explicitly stating that *VGI* was up to date:

You get things like trees across big rivers and things like that. Quite often within a few days you will get a notice on a forum saying "be careful there is a big tree stuck on the rock on 'this' bend" [#2-3-09].

However, only 6% of participants made reference to professional information being up to date. This is corroborated by observations during participation that river features such as weirs were present on PGI data sets (e.g. Ordnance Survey Maps), but the kayakers did not know if they were "*paddleable*" until they either received information from someone who had recently crossed the feature, or paddled there to investigate themselves.

While the language used by the participants to describe this point during the focus groups and observations was relatively subdued and with low intensity, their regular mentioning of experiences related to these topics demonstrated that the prominence of these issues was one which related to a great deal of their interests.

Considering the high overall number of references made in relation to the importance of information currency, it is clearly essential that information used reflects the conditions of the outdoor environment when the participant experiences it. The importance of this is highlighted by the information sources which can capture rapidly changing and largely unpredictable factors (such as river conditions) being seen as more accurate than slower responding sources:

[VGI is] often more accurate with [the inclusion of] real time information [#2-1-02].

This process of inferring the paddleable conditions of a river (see Figure 1) and reporting them through VGI channels as observed during participation demonstrated VGI's unique ability in delivering this need compared with the planned surveying practices of PGI. However diary studies demonstrated a preference for more general professional sources (e.g. geo-located weather reports) than volunteered reports.

Considering information depth (i.e. containing the level of detail required), although 12% of the participants commented that VGI is incomplete, 34% of participants perceived PGI as incomplete:

With maps, you can't gauge... [river] bank levels; they're more for distances and everything like that [#2-1-08].

The focus groups also suggested that PGI can (at times) describe the general overview of the outdoor environment, yet misses key details about the features most important to the participants. Observations also showed how participants would talk about large geographic areas with reference to professional information, yet specific details with reference to personal experience, forum posts or other amateur volunteer sources.

Eighteen per cent of participants commented that rather than utilise a single VGI source, they access multiple sources and *converge on the truth*:

I think you use it, all these little bits of information to build a whole picture of what you want to do [#2-1-04].

This contrasts with use of PGI – with only 9% of participants stating that they would use multiple sources of information rather than use a single PGI source. Regular emphasis was used by participants in the interviews to stress the importance of using information to confirm discovered VGI, particularly concerning trust.

4.3 Sources of external information

The sources of external information used by the participants are presented in Figure 5. A distinction is made between the source or originator of the information, and whether a formal or informal (Hawkins et al., 1995) distribution channel is used.

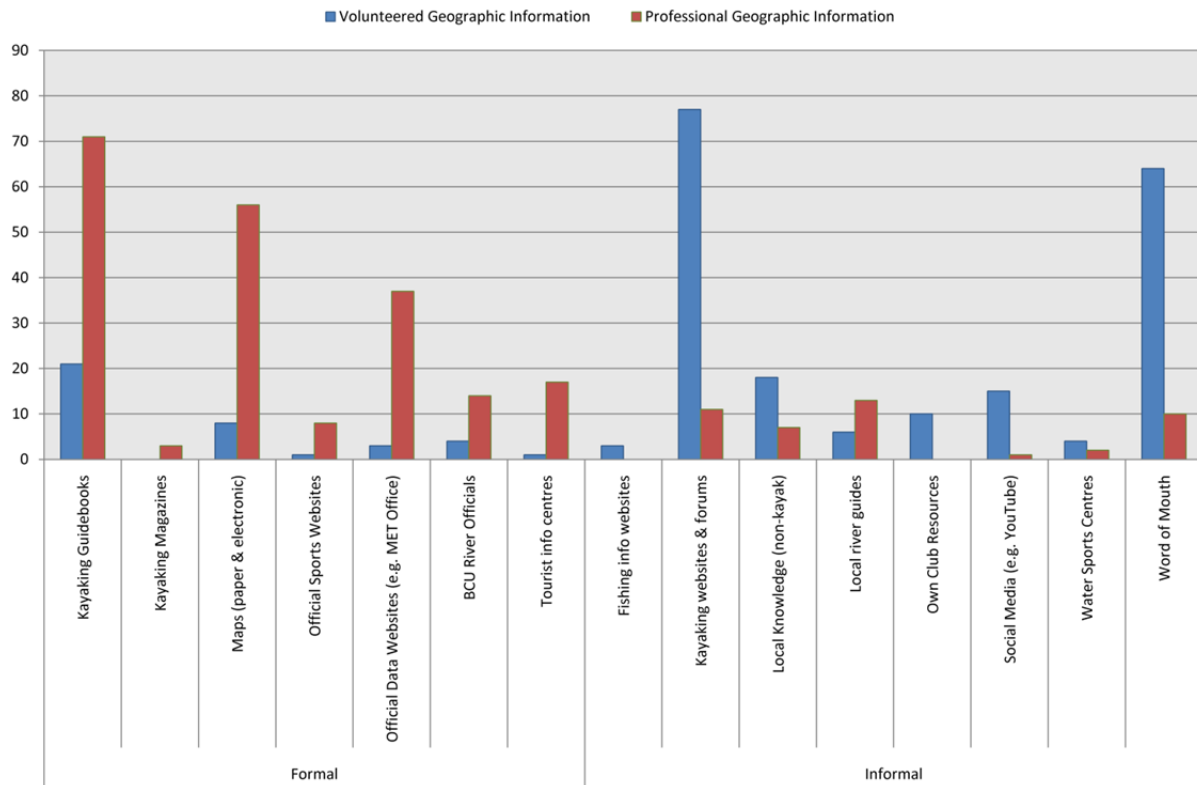


Figure 5. Sources of information; number of references made by study participants

As shown in Table 1, information identified as PGI was more likely to be out of date, while VGI had a higher tendency to reflect current conditions. However, Figure 5 shows that this is not a reflection of the level of professionalism (or amateurism), but is due to the typical channels of delivery of these types of information. As shown in Figure 5, PGI predominantly comes from formal sources such as printed media, while volunteered information comes from informal (and particularly online and face-to-face) sources. The most prominent informal (VGI) sources are expressions of people's personal experience through either word of mouth, or online discussion groups. Additionally, the features used to assess the conditions of the water during kayak trips (highlighted in Figure 1) may be official landmarks such as a water gauge, but require personal experience to understand and make use of these information cues.

5 Discussion

5.1 Access to information

One of the most unexpected findings from the study was the lack of either actual or desired access to GI in *real-time* while undertaking the kayaking trip. The kayaking environment itself presents challenges to information access: in particular the water-based environment and the lack of free hands. Much geographical user research has focussed on the delivery of location-based information; e.g. delivery to mobile phones (Sun and Song, 2009). However, the findings from this study question the extent to which such real-time information is useful, and instead suggest that when users are actually engaging with the environment, they are not necessarily motivated to find out more about geographical features but instead draw on internal information derived from their personal experience.

5.2 Influence of information currency

It was clear from this study that the extensive use of VGI and its perceived usefulness is due to its currency – i.e. the ability for it to reflect recent changes within the application domain. These findings are in agreement with Nolan (1976), Gitelson and Crompton (1983) and Schuett (1993) who

commented that within a travel situation, information received from informal sources were the most informative. This was predominantly due to its ability to reflect the recent conditions of the environment relative to the needs of the information seeker. Although VGI exhibits greater currency than PGI, this is not only a result of the volunteered nature of the information, but is also influenced by the channels through which it is communicated – i.e. where it comes from *and* how it is delivered. Therefore information distributed at regular, short intervals (rather than through the long intervals associated with traditional mediums) has a higher chance of reflecting current conditions and meeting the needs of the end-user.

The importance of this in a wider context may be seen through the work of Rogers (2003) who demonstrated that an *innovation* which can demonstrate a *relative advantage* compared to alternatives may be adopted and utilised in preference to others by an individual or community. While VGI may be hampered by its perceived complexity (highlighted by participants during observation) there is an opportunity for VGI enabled applications to create more usable products based on incorporating and promoting this relative advantage.

5.3 Impact of information depth and scope on user understanding

Although the low level of dissatisfaction with VGI being incomplete relative to the needs of the user (consumer) may be anticipated, it was not expected of PGI due to its associated *information redundancy*, providing more information to the user than the user would necessarily need. Ivergård (1982) commented that users' reactions to information are typically in relation to the amount of information *expected* rather than the amount actually found. Ivergård's comment may explain the level of dissatisfaction with PGI sources which (as this study has shown) are seen as having broad scope, but are perceived as incomplete in relation to contextual detail.

As Figure 3 shows, VGI is perceived as a more useful information source for understanding the specific detailed features which are important to the end user when planning an activity. In contrast, the use of PGI centres on the wide reaching topography of the outdoor environment. Figure 3 and Table 1 show that personal experience has a limited impact on understanding the outdoor environment, but enables analysis and validation of external information sources.

As highlighted by Manchala (2000) the user's experience of interacting with information can be seen as a direct measure of trust and the user's willingness to utilise the information in future instances. Consequently if VGI is utilised alongside PGI in applications in such a way as to increase the positive experiences for the user then the *trust* perceived by the user towards the application may be increased.

This research has demonstrated how the different elements of user perception (e.g. accessibility, accuracy, etc.) relate to their overall trust in the information. This is a useful development in the overall understanding and application of VGI relative to the work of Mummidi and Krumm (2008) in the need for demonstrable quality in VGI. Consequently the *depth* and *scope* of the information sources are most important to the user when searching for trip planning information. Although the *completeness* of individual information sources is important, it is more important that the whole collection of information sources (i.e. VGI and PGI together) produce a *complete* image when they are combined and considered alongside each other.

5.4 Volunteer reporting of activity experiences

During the focus groups and observations no comment was made on how the information accessed impacted on their experiences after the trip, despite participants being questioned about information use before, during and after river trips. However, within the kayaking community, *feeding back* of experiences via word of mouth is crucial to the information search activities of others, yet is not explicitly stated as a highly important activity. Therefore there exists a lack of perceived need to more formally feed such experiences back to others through VGI channels.

The low importance placed on actively disseminating experiences gained during the trip means that

within the kayaker community there exists a vast pool of potential VGI within individuals' personal experiences which is not freely available and easily accessible to others. This repository of information may therefore be considered *sticky* (Luthje et al., 2005). Here the *cost* of accessing such information is effectively *the ability to ask a question to the individual who holds it*. Without being in contact with that person, or knowing that they may hold such information their experiences are consequently unobtainable.

As highlighted by Rogers (2003) the most effective communication channels for dissemination of an innovation are through personal contacts and friends. Applications making use of VGI may be able to utilise this social communication aspect to improve the speed at which their innovation is diffused through society.

Importantly, *personal experience* can only become VGI when it is easily accessible to the wider community and stored outside of the mind of the user. However, only a portion of this personal experience is volunteered and made accessible. That which is volunteered is *volunteered with purpose*, describing key features of the environment perceived as important to the contributor. In contrast, a professional contributor will experience and record the outdoor environment relative to their reporting objectives, thus collecting information that will be superfluous to specific user groups.

6 Conclusion

This study has shown that the commonly held assumption that VGI is inferior to PGI (Keen, 2007) is unfounded, and the position of Crone (1968) that the most beneficial, accurate and useful GI can only come from professional sources is also no longer correct. PGI is more likely to describe the general geography and conditions of wide reaching features; e.g. river courses, hills, roads, etc. In contrast, VGI comes from a convergence of amateur sources, with each source describing specific points which are of perceived by the author to be of interest to others. Consequently the end-user seeking information may discover relatively high levels of detail about specific locations or features of interest from VGI, which are related to one another through the context of a general description of the outdoor environment derived from a PGI source.

This study has shown that it is more useful to consider the attributes of information (e.g. channels of communication, the update rate, ease of access) for instances relating to specific geographic regions rather than just the level of professionalism of the author; i.e. whether it is VGI or PGI. This brings into question the usefulness of the terms VGI and PGI in describing the usefulness of information from different sources. Therefore instead of specifying VGI as a singular and *best* information source for a project, a scheme could be made for utilising VGI for specific locations which change regularly, and PGI for other aspects of the project which are more static and slow changing in nature. The greatest opportunity for VGI to impact on outdoor activities is in situations where the current conditions of the geographic area are either not accessible via traditional cartographic means, are not sufficiently predictable through scientific methods, or are likely to have changed since they were last reported.

Although much research has focused on delivering real-time location-relevant information through GPS enabled mobile devices, this study has shown that in the context of outdoor adventure recreation the task where VGI may have greatest opportunity to make an impact is the information gathering stage prior to an activity. The potential for external information sources (including VGI) to make an impact while the user is actually participating in the outdoor activity may be very low. Instead, during the event itself internal information in the form of personal experience plays a key role in shaping the users decisions and actions.

This research has focused on the specific activity of kayaking; however it points towards a significant opportunity for increasing the usability of GI by integrating volunteer and professional sources in other contexts. The developers of future GIS systems could maximise the synergy of VGI and PGI through understanding how the different characteristics of each source can be used together to meet the contextual information needs of specific user groups and use contexts. The key implication for

those wishing to combine VGI and PGI together when designing applications is to consider both information sets not as simply *volunteer* or *professional*, but as two different yet equally valid information sets within the rich tapestry of GIS.

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