Linking the "Internet of Things" to social media: a look at the Vaal Dam

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Abstract

The "Internet of Things" is the new paradigm where "things" are becoming more widely connected to the Internet. More and more inanimate objects (such as cars, bridges, cell phones, digital cameras, and telescopes) are equiped with digital intelligence and are, thereby, given the capability of connecting to the Internet. Even some animate (or nearly animate) objects are becoming connected to the Internet including pets with embedded chips and a human pacemaker with a wireless link. This paper describes a joint project with CSIR Meraka and the South African Department of Water Affairs where the Vaal Dam is given a social media presence on Twitter, Facebook, and MXit.

Keywords : Twitter, Facebook, Beachcomber, Internet of Things, Vaal Dam

1. Introduction

The "Internet of Things" is the phenomenon of more and more "things" (as opposed to people) becoming connected to the Internet. More and more "things" are being embedded with digital intelligence and becoming connected to local networks. These local networks are slowly becoming incorporated with the traditional Internet (de Saint-Exupery, 2009; EPoSS, 2008; Fleisch, 2010). For example, luxury cars have long had tracking devices which connected to networks belonging to the tracking company. It has been only recently, however, that the owners of the cars were given the facility to track their own vehicles through a web interface. A similar thing has happened with cell phones. Cell phones have been able to access the Internet for years. But it is a recent phenomenon where a cell phone owner could track his physical cell phone through a web interface.

More and more physcially large "things" are creating a presence for themselves on social media networks (Cramer & Büttner, 2011). Twitter has become a common place where physically large "things" can tweet about themselves. Telescopes tweet their coordinates. Seismographs placed along the San Andreas fault tweet their motion. Bridges in London tweet whether they are up or down.

http://www.twitter.com/towerbridge

http://www.twitter.com/lovelltelescope

http://twitter.com/USGS_EQ_SoCal

By using social media mechanisms, these "things" can provide the public with important information for which the public may not have ever searched.

A prime example is the state of the Vaal Dam during the recent flooding of December, 2010 – January, 2011. The Department of Water Affairs provides an open website where people can view the state of the various dams in Gauteng and the Free State (Department of Water Affairs, 2011). This website (http://www.dwaf.gov.za) provides critical information about water flow levels and dam levels. Unfortunately, the website is not a part of most people's social interaction with the Internet.

This paper describes a joint project between CSIR Meraka and the Department of Water Affairs where the Vaal Dam wall is given a presence on Facebook, Twitter, MXit, and Jabber. This presence is created in the first person with the dam tweeting its status as, for example, "I am 100.5% full!". Besides providing important information about the water level, the presence also provides interesting information about itself including recent news, photographs, videos, books, and scholarly articles.

2. Research question and objective

This joint research project between CSIR Meraka and the Department of Water Affairs was divided into two separate sections: a technical section and a social section. The research question for the technical portion was

"Can the Vaal Dam be successfully connected to social media?"

The research question for the social section was

"What is the level of social interaction between the Vaal Dam Internet presence and its followers and friends"

The research objective for the technical section of this project was

"Connect the Vaal Dam to Twitter, Facebook, and various other social media"

The research objective for the social section of this project was

"Evaluate the level of social interaction between the Vaal Dam and its social connections"

An iterative research methodology was used. Different stakeholders were involved at the different steps in the research iterations.

3. Department of Water Affairs data

The South African Department of Water Affairs maintains a network of flow meters and level sensors on the Vaal Dam, Vaal River, and its tributaries (Department of Water Affairs, 2011). The authors of this paper held face-to-face meetings and telephonic meetings with the researchers and scientists at the Department of Water Affairs. The technical information about the actual sensors and flow meters is beyond the scope of this paper.

The Department of Water Affairs collects this information and publishes it for public consumption using various methods including a traditional website, mailing lists, and news media briefings during flood seasons.

Using "Internet of Things" technologies, the researchers planned to more widely disseminate this information using various social media including Facebook, Twitter, email and chat.

4. Technicalities

This section describes how the Vaal Dam was connected to Facebook and Twitter and other social media from a technical point of view.

4.1 Beachcomber

Beachcomber is a JEE (Java Enterprise Edition) application which links the "Internet of Things" to the "Internet of People" (Butgereit & Coetzee, 2011). Beachcomber runs using the Mobicents Communication Platform (Deruelle, 2008). It provides a wide range of protocols to allow "things" and people to communicate with each other mediated by a business process.

As can be seen in Illustration 1, various input and output protocols are supported by Beachcomber including MXit, XMPP, POP3 email, Twitter, etc. Beachcomber either queries or receives information from "things". In other words, the "things" in question may push information directly to Beachcomber or Beachcomber may query the "things" for information. Depending on routing information, Beachcomber then forwards the information to a business service. The business service processes the information and then, again depending on routing information, the information is sent out through various channels.

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┌─────────────────────────────────────────────────────────────┐
│         ┌──────────┐        ┌──────────┐                      │
│         │ Business │        │ Business │                      │
│         │ Service  │        │ Service  │                      │
│         │   #1     │        │   #2     │                      │
│         └────┬─────┘        └────┬─────┘                      │
│              │                   │                            │
│         ┌────┴───────────────────┴─────────────────┐         │
│         │                                           │         │
│         │              Beachcomber                  │         │
│         │                                           │         │
│         └─────────────────────┬─────────────────────┘         │
│   ┌─────────┬─────────┬───────┴──┬──────────┐                 │
│ ┌─┴───┐  ┌──┴──┐   ┌──┴──┐    ┌──┴──┐                         │
│ │Twit-│  │ Bar │   │XMPP │    │ JMS │                         │
│ │ ter │  │Code │   │     │    │     │                         │
│ └─────┘  └─────┘   └─────┘    └─────┘                         │
│ ┌─────┐  ┌─────┐   ┌─────┐    ┌─────┐                         │
│ │ QR  │  │HTTP │   │ SMS │    │MXit │                         │
│ │Code │  │     │   │     │    │     │                         │
│ └─────┘  └─────┘   └─────┘    └─────┘                         │
│          Illustration 1: Beachcomber architecture            │
└─────────────────────────────────────────────────────────────┘
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Illustration 1: Beachcomber architecture
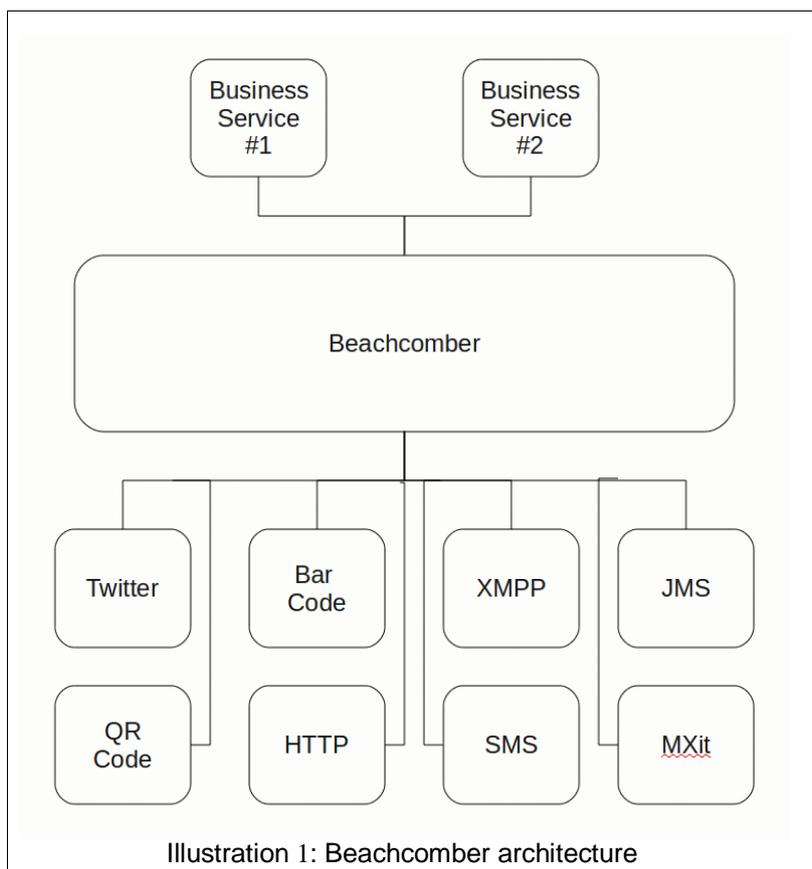
In the case of the Vaal Dam, Beachcomber queried the Department of Water Affairs for the current water capacity of the Vaal Dam (Department of Water Affairs, 2011). This was done via HTTP (Hyper Text Transfer Protocol). Beachcomber forwarded the information to a business service. The business service massaged the information and forwarded it to Twitter. In addition, however, the business process stored the information for future queries by people via MXit, Jabber, Email, or Google Earth.

Besides providing just water capacity levels of the Vaal Dam, Beachcomber "combed" the Internet for additional information about the Vaal Dam. This included querying various websites for additional information about the Vaal Dam.

For example, Beachcomber queried You Tube for any interesting videos of the Vaal Dam with its sluice gates open. Beachcomber queried Google News for any news articles about the Vaal Dam and water levels. Beachcomber queried the CSIR Research Space for any scholarly articles about the Vaal Dam. Beachcomber also queried websites such as Flickr for photographs, Google Books for interesting open source books, and Google Scholar for other scholarly articles. This additional information was randomly appended to the tweets and status updates about the Vaal Dam to provide additional information to the the Vaal Dam's followers and friends.

4.2   Email, XMPP, MXit, HTTP support

Mobicents is an open source communication framework (Deruelle, 2008). Mobicents supports two types of objects: resource adaptors and service building blocks. Resource Adaptors can be conceived as being lower level objects. Service Building Blocks can be conceived as being higher level objects.

Mobicents is released with a number of Resource Adaptors to support common protocols including HTTP and XMPP. There are two HTTP Resource Adaptors. One is for outgoing HTTP calls or HTTP client calls. The other is for incoming HTTP calls or HTTP server calls. The XMPP Resource Adaptor provided full XMPP support.

These two resource adaptors (along with additional resource adapters which were developed by the researchers including POP3 Email, MXit and Twitter) provided the various communication protocols or channels which were needed by the Vaal Dam Internet presence.

One service building block was developed to handle the specific logic of processing the information regarding the Vaal Dam.

4.3 Google Earth support

Google Earth support was provided by merely publishing and KML file with the current water levels in the Vaal Dam along with the required coordinates. Table 1 shows a typical KML output. This KML produces a nice "fly in" to the Vaal Dam along with the appropriate water level information as can be seen in Illustration 2.

Table 1

```
<Placemark>
<name>The Vaal Dam</name>
<description>
At  2011-04-13 18:00 My water level is 22.277m above outlet.
I am 96.91% full.
</description>
<Point>
<coordinates>28.11596,-26.882323</coordinates>
</Point>
<LookAt>
<longitude>28.11596</longitude>
<latitude>-26.882323</latitude>
<altitude>00</altitude>
<heading>165</heading>
<tilt>70</tilt>
<range>600</range>
```

```
<altitudeMode>relativeToGround</altitudeMode>
</LookAt>
</Placemark>
```

4.4   Twitter and Facebook integration

For Twitter support, it was necessary to write a Twitter Resource Adaptor. This was done using the Twitter4J utility library. At the time of writing this paper, the Twitter Resource Adaptor only supports output to Twitter. It does not support input from Twitter. An example of the Twitter output can be seen in Illustration 3. The Twitter account can be found at

http://www.twitter.com/vaal_dam

A Facebook account was also created. The Facebook user "Vaal Dam" had been used numerous times. The researchers chose the Facebook name "Vaal Dam Levels" to distinguish this account from the many others already called "Vaal Dam". The Facebook support was implemented via Twitter using the Twitter Facebook application. This meant that anything that was posted to a specific Twitter account would be automatically forwarded as a status update to Facebook. No additional work was required on Beachcomber to support Facebook status updates. An example of one of the Facebook pages can be seen in Illustration 4. There are two presences on Facebook. One is a Facebook personal page and one is a Facebook public place. They both show the same information but offer a different type of user experience.

http://www.facebook.com/vaal.dam
http://www.facebook.com/profile.php?id=168680016518173&refid=0
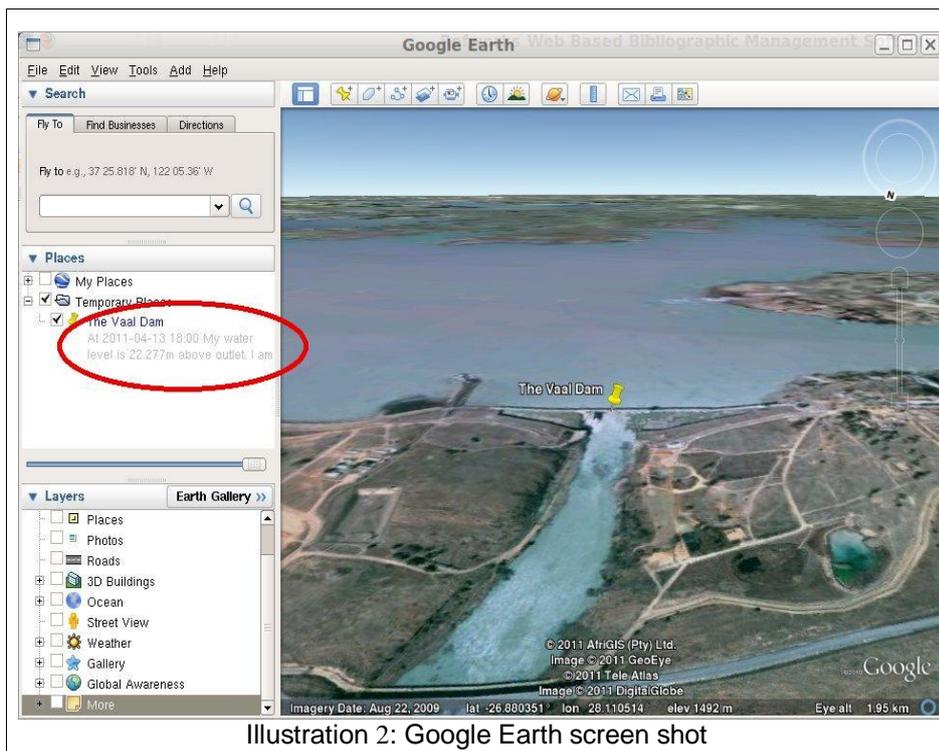
Illustration 2: Google Earth screen shot
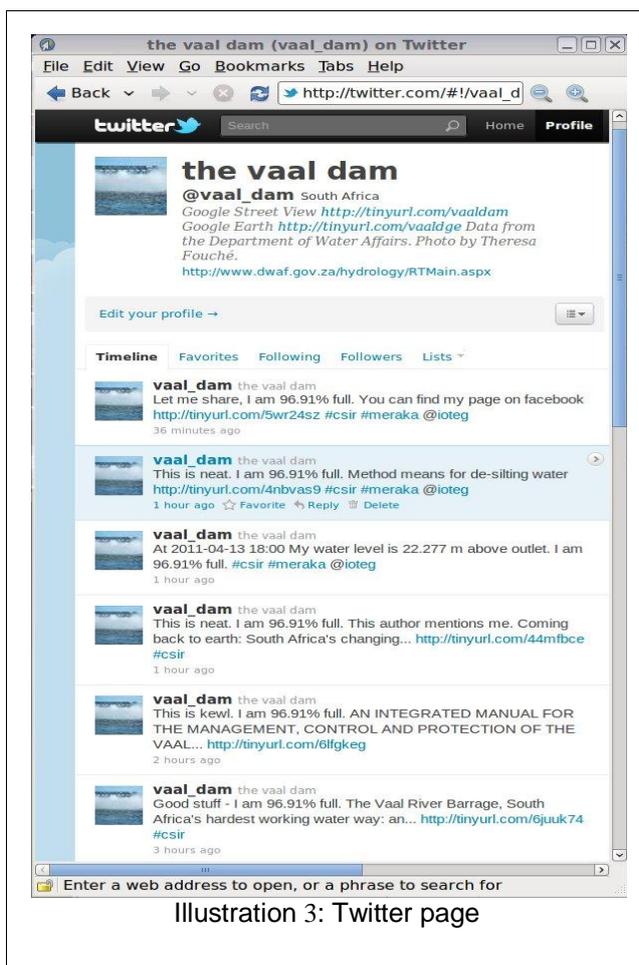

Illustration 3: Twitter page
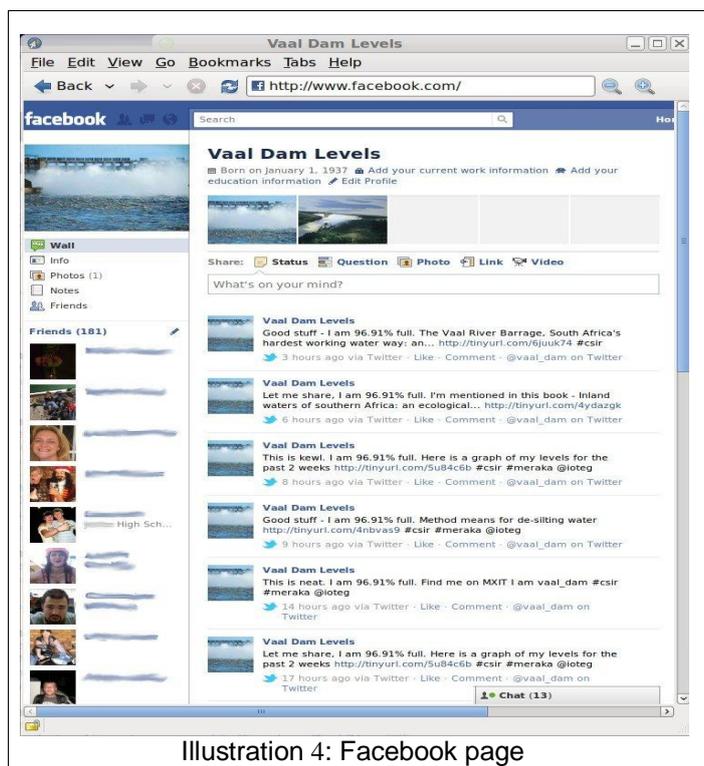
Illustration 4: Facebook page

4.5   Other interesting information

In an effort to make the tweets and status updates interesting, information was also scraped from various additional websites including:

YouTube

Google News

Google Scholar

CSIR Research Space

Google Books

Flickr

Google Images

This information was appended to the actual capacity status to provide the followers and friends more information about the Vaal Dam.

5.   Social media

5.1   Introduction

The use of social media is considered an essential complement to the communication strategy of any organisation wishing to engage with its target audiences. This section of the paper sets out to examine and assess the efficacy of the Vaal Dam presence in terms of the tenets of social media.

Social media are media for social interaction. The practice is characterised by the use of web-based and mobile technologies to turn communication into interactive dialogue.

Andreas Kaplan and Michael Haenlein define social media as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, which allows the creation and exchange of user-generated content" (Kaplan & Haenlein, 2010). A common thread running through all definitions of social media is a blending of technology and social interaction for the co-creation of value.

5.2 Limitation of a static website

In the case of the Department of Water Affairs, the prime communication mechanism for accurate and useful information on the Vaal Dam is its static website (Department of Water Affairs, 2011). The uptake of this information is, however, limited by the following factors:

- The Department of Water Affairs is not mandated to "push" this information as flood warnings. The responsibility for disaster management vests with the local municipalities
- The website groups information on the Vaal Dam (along with other water bodies) in its Shortcuts menu under the heading, Hydrology (Data, Dams, Floods and Flows). The information requires the visitor to make an educated guess at where information on dam levels is housed.
- The information on dam levels is visualised as a graph with a brief summary as follows:
  2011-04-21 07:00 Capacity: 96.9 %
  Inflow: 84 m^3/s Outflow: 15 m^3/s

While the accuracy and the timeliness of information are indisputable, the fact that it is hidden at a third level and is presented in a scientific format, does not auger well for uptake by the general public.

5.3 Value added by social media information

The willingness of the Department of Water Affairs to undertake this project attests to a realisation that a new approach is needed to share information on the Vaal Dam.

The research question is therefore whether the Twitter and Facebook additional social information created by Beachcomber (bearing in mind that only dam levels are provided) has been successful in encouraging social interaction between the Vaal Dam and its followers (Twitter) and friends (Facebook).

Four measures were applied in evaluating this interaction:

- Reach
- Influence
- Media uptake
- Assessment of the quality of the online experience.

6.   Evaluation

This project is evaluated at two levels: a technical level and a social level.

6.1   Technical evaluation

From a technical point of view, the research objectives where achieved. The Vaal Dam did successfully communicate using Twitter, Facebook, and other social media including MXit and Jabber. Thus, the answer to the research question is Yes, the Vaal Dam can successfully connect to social media.

There was one minor problem which also affected the social evaluation. During the initial configuration of the Facebook user, the decision was taken to allow Facebook friends to tag the Vaal Dam in photographs. This was an attempt to encourage a community feeling and to enhance the user experience. Unfortunately, the Vaal Dam user was tagged in inappropriate content and that facility was later disabled. This affects the fourth social measurement mentioned in 5.3 above, the assessment of the quality of the online experience.

6.2   Social evaluation

As mentioned in section 5.3 above, the value of social media information has four measurements: reach, influence, media update, and quality of online experience. Each will be discussed in detail.

6.2.1   Reach

This is measured in terms of the number of followers and friends:

Twitter

At the time of writing this paper, there are 283 followers of the Vaal Dam Twitter feed. This number is low compared to the number of followers of other "things", such as Tower Bridge in London which boasted 3804 followers at the time of writing this paper. In addition, it is disproportionate to the number of Twitter accounts being followed by the Vaal Dam (1 459). The Vaal Dam is therefore not being followed by everyone it follows.

The Vaal Dam followers comprise the following groupings:

- Business representatives, including advertising agencies
- Organisations with a focus on water management, quality and education
- Scientists
- News agencies and journalists
- Civil society advocacy groups
- High school students with an ecological interest
- Entertainers
- Anglers
- Vaal Dam-based tourist venues
- Individuals (local and abroad)

The broad spectrum of followers suggest that the current levels of engagement through the sharing of additional information (tweets as at 24 April were 1 638) are sufficient to retain but not to increase the number of followers.

Additional actions envisaged to engage with a broader grouping include the following:

- Engagement with the Department of Water Affairs to communicate the availability of this social medium.
- Assessment of the value of this information to the school geography curriculum
- The inclusion of the questionnaire to existing followers to surface the reasons for following the presence.
- Additional promotional efforts at venues and in community newspapers in the Vaal Dam area.

Facebook

The Vaal Dam Levels has both a personal page and a public places page.

This personal page has 182 friends. The public places page is "liked" by 13 people.

There are no discussions, one photograph and limited activity on the wall. This is primarily due to tagging being disabled. After the initial activity, the social medium has not seen the requisite social interaction. This suggests that some human interaction to monitor tagging and photographs is necessary.

6.2.2 Influence

Twitter

The Vaal Dam tweets are not retweeted. It has four lists following it, three of which seem to be related to the arts and business, and one with a scientific focus. In particular, the Twitter list @EricHarmsen/agr-water-management-5 covers posts related to the efficient use of water in agriculture.

This suggests that the social information is not compelling enough for followers to retweet. The limited number of lists also indicates a perception of limited value in terms of sharing in a collective context.

Additional actions to be taken are further engagement with the Department of Water Affairs to target groups that may have relevant lists on Twitter.

Facebook

An unrelated Facebook page entitled "Vaal Dam" is "liked" by 77 people. This compares favourably with other smaller public interest sites, such as the Pilanesburg Game Reserve, a landmark (with 87 people "liking" it).

Posting more information (photos and other visuals) may be the way to encourage others to post or share photos. Obviously, care must be taken when information is supplied by Facebook friends.   This suggests that while the page is a complementary mechanism, it is not used as a mechanism for sharing live information.

6.2.3   Media uptake

A media release on the Vaal Dam project was sent out jointly by the Department of Water Affairs and the CSIR on 23 March 2011 to coincide with World Water Week. The uptake by the mainstream and electronic media is summarised below:

Medium	Title	Likes	Tweets/ Comments
www.Info.gov.za/speech	Vaal Dam on Facebook and twitter		
www.csir.co.za	Vaal Dam on Facebook and Twitter		
www.mediaclubsouthafrica.com	Vaal Dam becomes a social networking hit	4	
www.itweb.co.za	Dam splashes onto Facebook, Twitter		
www.mydigitallife.co.za	Dam splashes onto Facebook, Twitter	2	3
www.fin24.com/	Now the Vaal Dam can be your 'friend'		1
www.citizen.co.za/	Vaal Dam on Twitter and Facebook		
www.nuus24.com	Maak die Vaaldam jou vriend op Facebook of Twitter (Translation:		

	Make the Vaal Dam your friend on Facebook and Twitter)		
www.jacarandafm.com	Vaal Dam information on Twitter and Facebook		1
Jacaranda 5 pm news			

The uptake has been favourable but limited social interaction happened as a result.

6.2.4 Assessment of the quality of the online experience

Because of two incidents where Facebook friends tagged the Vaal Dam with inappropriate content and because of the public nature of the organisations involved in this research (CSIR Meraka and the Department of Water Affairs), tagging of content was disabled on the Facebook account. This meant that Facebook friends could not interact with with the accounts and this limited the quality of their online experience.

No attempt was made to interact with followers on the Twitter account to assess whether the richness of the online experience was matched by the actual experience that people have of the Vaal Dam. An analysis of the tweets of Vaal Dam followers was not undertaken but may be useful in surfacing these perceptions.

At the time of writing the paper at the conclusion of South Africa's summer rainy season, the dam is full but it is unlikely that flooding will occur at this stage. It may therefore be that interest in news about the Vaal Dam levels may pick up once the rainy season commences.

7.   Conclusion and further research

The technical research objective was achieved and the technical research question was answered affirmatively. The researchers are confident that the Vaal Dam can continue an automated social media presence on the Internet.

From a social media perspective, however, it would appear that a totally automated social presence is not adequate especially in the case where large organisations are involved. For example, care was taken when automatically searching Google News for information about the Vaal Dam. The keywords "Vaal Dam Sluice Gates" were used (and not just "Vaal Dam" itself) to avoid news articles about accidents, murders, or protests which may occur in the Vaal Dam area. However, one can imagine a rare incident of protesters on the Vaal Dam wall itself where Google News would return embarrassing content for the stakeholders in this research project. In addition, although allowing Facebook friends to upload and tag content would enhance the online user experience, a human would be required to monitor the actual content.

The extra content scraped from various external website such as YouTube and Google Books was all free for public consumption. This was aligned with the goals

of major stakeholders of this research. However, information from propriety websites may enhance this social presence. For example, Amazon Books has numerous interesting books for sale about the Vaal Dam which may be of interest to followers and friends. Various tourist websites have numerous links to hotels, guest houses, and B&Bs (Bed and Breakfast accommodation) in the area which may be of interest to followers and friends. If this had been a commercial project (in contrast to a research project), links to those sites could be added to the feeds.

In conclusion, the researchers are satisfied with the initial outcomes of this project. More research needs to be done in moderating input from friends. In addition, more research into the commercialisation potential of such a project also needs to be done.

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