

HARVESTING GEOSPATIAL DATA FROM MOBILE PHONES:
PRACTICAL APPLICATIONS FOR MANAGING INVESTMENTS IN TOURISM
INFRASTRUCTURE

by

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ABSTRACT

Harvesting Geospatial Data from Mobile Phones: Practical Applications for Managing Investments in Tourism Infrastructure

Master of Planning in Urban Development, 2013

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This paper explores the different methods of harvesting geospatial data related to mobile phone technology and investigates the applicability of these methods to the Ontario context. The three methods investigated include: data harvesting from mobile phone operators logs; creating a new social media application for data harvesting; and, mining existing social media applications for applicable datasets. Researchers Dr. Deborah Edwards at the University of Technology Sydney and Dr. Rein Ahas at the University of Tartu were interviewed on their respective methods of data collection. These were followed by an interview with Eli Perell, Senior Policy Advisor to the Tourism Policy & Research Branch at the Ontario Ministry of Tourism, Culture and Sport, to determine whether the Ministry would be interested in this type of research as well as its viability in the Ontario context. The paper concludes that two of these three methods are applicable in the Ontario context and provides the Ministry with recommendations to begin implementation.

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1.0 INTRODUCTION

Planning for tourism infrastructure in Ontario is difficult due to a lack of detailed, location-specific data regarding tourists' geospatial movements and levels of satisfaction with tourism-related services and facilities. While international border crossing and accommodation statistics are reliable, there is very little information available on the modes and patterns of travel within the province or on the evaluation of attractions from a tourist's point of view. The Ontario Ministry of Tourism, Culture and Sport has received numerous recommendations that this information is required in order to build a compelling case for foreign investment in tourism attractions and infrastructure as well as improve the highway way-finding system (signs that improve traffic controls by alerting drivers to locations of and routes to nearby attractions).

Over the past decade, the wealth and quality of data being produced by the proliferation of mobile phones and the advent of geo-capable devices have exponentially increased. These new technologies provide new avenues for tracking tourism-related activities using mobile positioning data. Mobile positioning data produces geospatial information obtained from mobile phones and other geo-capable devices, allowing the longitude, latitude, and altitude of any given geo-capable device to be known in real time. There are three main sources of mobile positioning data that researchers working in the tourism sector are exploring: mobile phone operator logs; existing smartphone applications; and, developing new smartphone applications. This paper will explore the quality and limitations of the data sources used by the Ontario Ministry of Tourism, Culture and Sport, the emerging methods of improving the tourism dataset using new technologies, and, finally, make recommendations on the applicability of these new methods to the Ontario context.

2.0 RESEARCH QUESTION

Can geospatial data from mobile phone technology be harnessed to provide useful information for planning tourism infrastructure investments in Ontario?

3.0 RESEARCH METHOD OBJECTIVES

To investigate the validity of geospatial data as a means of improving knowledge about tourist behaviour as well as practical applications for tourism strategies and planning, the researcher has conducted key informant interviews with the researchers exploring the applications of this technology. In Australia, Dr Deborah Edwards, University of Technology Sydney Senior Research Fellow, has been interviewed. In Estonia, Dr. Rein Ahas at the University of Tartu and principal of *Positium LBS* has been interviewed. Questioning centred on how well the data translated into improving tourism infrastructure.

Next, to determine whether this kind of research would be of use to policy makers and practitioners within the Ontario tourism industry, a key informant interview was conducted with Eli Perell, a Senior Policy Advisor to the Tourism Policy & Research Branch at the Ontario Ministry of Tourism, Culture and Sport. The emphasis centered on what data the Ministry uses to make tourism planning and strategic decisions compared to the data they would ideally like to use. Lastly, the data that can be obtained through mobile technology and the Ontario tourism officials' ideal datasets will be compared to determine if there is feasible overlap.

The expected outcome and contribution to planning knowledge is to determine the viability of using geospatial data from mobile technology for the purpose of improving the quality of data used to inform tourism infrastructure planning and strategies in Ontario.

4.0 RESEARCH METHOD IN DETAIL

Literature Review

The literature review includes all academic texts and news articles related to mobile positioning data and application in planning fields with a special emphasis on tourism planning.

Selection of Subjects

The first set of subjects selected for this project includes those researchers who have published in English regarding mobile positioning data for tourism planning. There are two known researchers who have used mobile positioning data for the purposes of improving tourism infrastructure and both were interviewed.

The second set of subjects includes the senior public officials in the tourism policy and research branch of the Ontario Ministry of Tourism, Culture and Sport whose job description includes making decisions about data, information, and tourism planning. These public officials have the decision-making power and seniority to discuss this process and the applicability of using mobile positioning in the Ontario context. One such official was interviewed.

All together there were three interviews conducted; two researchers as well as one public official from Ontario's department of Tourism who spoke to the issues at hand.

Determination of Interview Content

The interview questions for the researchers were based on the current applications revealed in the literature related to the advantages and disadvantages of each method of data collection, application, and whether the process will be repeated in the future. The key source of the interview questions were the published studies of their research. The interview questions for the public official in Ontario were related to the applicability of the methods used in Estonia and Australia. Please see Appendix A for an overview of interview questions.

Application

The analysis of the interview responses was done qualitatively through descriptive comparisons.

Recording Method

The method of collection was hand-written notes. There was assurance that the research portion of the study involving interviews was approved by the Ryerson Ethics Board.

Findings

The findings were expected demonstrate whether data harvesting of mobile positioning data for tourism planning is applicable in the Ontario context.

5.0 TOURISM DATA IN ONTARIO

The Ontario Ministry of Tourism, Culture and Sport (MTCS) is responsible for providing market profiles and travel forecasts for marketing plans, development plans and feasibility studies as well as evaluating the impact of proposed policies, specific events, and development projects (Oakes, 2013). A series of recommendations were made to the MTCS in *The Ontario Tourism Competitiveness Study* (February 2009), including conducting better regional tourism research, facilitating unprecedented levels of private investment in tourist attractions and infrastructure, and improving the effectiveness of Ontario's marketing strategies. To achieve these priorities, according to recommendations from *Ontario's Tourism Investment Strategy and Implementation Plan* (2011), the Ministry should produce an investment attraction package that includes:

- “The importance of tourism infrastructure (transportation, air etc.), and potential investment opportunities therein;
- Regularly updated reporting on tourism investment, visitation and economic impact in Ontario, supplemented with forecasts;
- Strong destination branding – both tourist and investor-oriented – at both a provincial and regional level; and
- A focus on world-class experience and event-based assets that represent primary product development and investment opportunities” (Miller Dickinson Blais, 2011, 21).

One of the challenges to producing such an investment attraction package is that the MTCS cannot definitively state where tourists in Ontario go, the routes which they take to get there, and when they travel on those routes or visit those destinations and attractions (Perell, 2013). Having this information would make it easier to build a compelling case that identifies development-ready tourism opportunities in attractions and infrastructure. This was reaffirmed by the MTCS's 2012 report *Welcoming Investors: A Tourism Investment Attraction Strategy for Ontario*, which asks industry partners to help the MTCS identify major tourism generators as well as highlight local tourism strengths and clusters (Ministry of Tourism, Culture and Sport, 2012). Knowing where and when tourists go, and the routes they use to get there, would provide a compelling argument for investing in the specific parts of the Ontario tourism industry as well as improving the marketing strategies, all of which would aid in effectively expanding existing markets.

The absence of this type of data is manifested in Ontario's tourism way-finding system as noted by *The Ontario Tourism Competitiveness Study* (February 2009). The term way-finding refers to the organization of cues that inform people of the route to and location of various destinations.

The Study states that the tourism way-finding system in Ontario is poorly designed and must be improved (ibid). The MTCS supervises the provincial way-finding system, called Tourism-Oriented Directional Signs (TODS), which is operated by a private, third company *called Canadian TODS Limited*. *Canadian TODS Limited* is responsible for increasing the awareness of Ontario tourism attractions located off provincial highways, enhancing traffic control through advanced-warning-of-turns signs, and promoting and strengthening tourism province-wide. Data that demonstrate the geospatial flows of tourists have the potential to immensely improve the provincial way-finding system.

To fulfill its responsibilities the MTCS primarily uses four data sources: the International Travel Survey (ITS) from Statistics Canada; the Travel Survey of Residents of Canada (TSRC), also from Statistics Canada; and the Travel Intentions Survey, which is a study conducted by the MTCS. The information collected from these studies is mostly voluntary, abstract in terms of evaluating Ontario's tourism products, and cannot be mapped to demonstrate where and when different market segments of tourists are exploring Ontario. Lastly, the MTCS uses historical data and performance indicators from a wide variety of sources to measure the performance of the tourism sector. The MTCS has limited data on the geospatial movements of tourists once they are within Canada and on their levels of satisfaction with specific attractions. The following will describe the primary sources of data used by the MTCS and their limitations.

The Travel Survey of Residents of Canada (TSRC) is a voluntary supplement to the Labor Force Survey, a mandatory monthly household survey of about 54,000 households that provides official estimates of employment and unemployment in Canada. The TSRC has a response rate of 75% and is used to provide information about the volume of trips and expenditures for Canadian residents by trip origin, destination, duration, type of accommodation used, trip reason, and mode of travel, as well as to provide information on travel incidence and to provide the socio-demographic profile of travellers and non-travellers (Statistics Canada, 2012). Because the TSRC is voluntary and captures a random sample of households across Canada, it captures a wide breadth of information. However, it cannot capture any information on levels of satisfaction with tourism products and services as well as the patterns of movements within each trip taken.

The International Travel Survey (ITS) is comprised of several components and provides statistics on the number of international travellers by type of transportation, place of entry, and evaluation of tourism experiences in Canada. The Frontier Counts register the number of international travellers entering and exiting Canada by land and air vehicles while CANPASS registers international travellers entering Canada by private plane or boat. These components ensure that the number of international travellers entering and exiting Canada is accurate as is the mode of their transportation at the point of entry or exit. The Mail-back Questionnaires and Air Exit Survey of Overseas Travellers are voluntary surveys conducted at all ports of entry into Canada, which have a

few structural differences but are comprised of nearly the same content. These voluntary surveys ask participants to check off attractions and activities on a comprehensive list, list all the types of transportation used, and rate general themes related to tourism. For example, the survey asks participants to rate the transportation services, accommodation services, hospitality of local people, value for money, and variety of things to do and see on a scale from good-to-average-to-poor-to-not-applicable (Statistics Canada, 2011). The generality of these surveys limits their usefulness for overall evaluation, providing feedback and educational training to tourism operators, and deciding upon strategic direction for improvement. The difference between “good” and “average” as a response to any of the evaluation questions without space for including specific comments does not provide an opportunity for institutional learning. There may also be experimenter bias in the responses received. Furthermore, the surveys do not capture the geospatial movements of tourists between attractions, only the number of attractions visited.

The Ministry-led Travel Intentions Survey is a self-selection, panel-based survey that is conducted online with a sample draw from MTCS Canadian and US Online Access Panels (Ontario Ministry of Tourism and Culture, March 2011). It measures:

- The respondents’ propensity to travel;
- The percentage of Americans planning to visit Ontario on their next pleasure trip, divided by destination and trip type;
- And, perceptions of Ontario.

The most recent Travel Intentions Survey results showed that Ontario has little aspirational marketing power and that Americans are largely unaware of the attractions on offer in Ontario (ibid). This survey provides excellent information on the perceptions of the tourism offerings in Ontario, but, again, cannot capture the geospatial movements of tourists nor evaluate their experiences of attractions in Ontario.

Lastly, the MTCS provides publicly available historical data and performance indicators. Historical data include inbound visits and spending, outbound visits and spending, tourism receipts and economic impact, travel accounts and price indexes, accommodation data, and tourism-related establishments and employment (Ontario Ministry of Tourism, Culture and Sport, 2012).

Comparatively, performance indicators include international border crossings, hotel occupancy and hotel average daily rate, employment in tourism-related industries, travel price index, visitor enquiries (on the phone at 1-800-Ontario, online at www.ontariotravel.net, and in person at Travel Information Centres), and attendance numbers at government agencies such as the Ontario Science Centre and the Royal Botanical Gardens. While these datasets provide valuable information for comparing the performance of the tourism sector over time, they cannot explain where tourists go outside of their hotels and government owned attractions nor do they evaluate those experiences.

The current sources of data used by the MTCS capture a broad range of data from perceptions of Ontario's tourism products to the modes of transportation used by every traveller to enter and exit the country. However, none of the data sources have the ability to capture the geospatial movements of tourists within Canada nor is there a process of systematically evaluating the tourism products and services outside of the broad attempt at evaluation put forward in the Mail-back Questionnaires and Air Exit Survey of Overseas Travellers. The biggest limitation of the data sources is the level of granularity (Oakes, 2013). The recommendations suggested in this paper provide processes for improving the level of granularity of tourist geospatial data, which will help to fulfill the strategic objectives of the MTCS in terms of building the case for new private investment in new attractions, improving regional tourism, and creating more effective marketing campaigns.

6.0 NEW TECHNOLOGIES: GIS DATA, SMARTPHONES, & SOCIAL MEDIA APPLICATIONS

The increased popularity of smartphones and geo-capable devices over the past decade provides new avenues for obtaining tourism-related data using mobile positioning technology. Currently there are three main sources of data collection that arise from the increased popularity and usage of geo-capable devices: from mobile phone operator logs, from existing smartphone applications, and by developing new smartphone applications. The following will explain how these three avenues collect geospatial data on mobile phone users.

Mobile phone operators collect geospatial data about their users via a unique address, sometimes called a media control access (MAC) address. According to a report by Ontario Information and Privacy Commissioner Ann Cavoukian, this information is universally collected in mobile phone operator logs without obtaining explicit user consent (The Canadian Press, 2011). Foreign tourists can be identified through their MAC addresses, including their presumed nationality based on where the mobile phone is registered. Network operators sometimes sell this information to companies known as location aggregators, which maintain databases for commercial and learning purposes. For example, mobile data have been used for studying transportation and urban development (Asakura & Hato 2004; Reades et al. 2007; Shoval 2007; Ahas et al 2010), tourism (Ahas et al. 2008; Tiru et al. 2010), migration (Silm & Ahas 2010), and emergency management (Bengtsson et al. 2011). However, researchers who want to use mobile positioning data from mobile phone operator logs have found that gaining private sector trust in order to access the data is the biggest obstacle (Ahas et al, 2008).

There are many practical, ethical applications of this form of technology. For example, when an emergency 911 call is placed, network providers in Canada are required to provide Emergency Services with the location of that phone. Current technology allows the accuracy of that location to be within 50 meters in dense urban areas.

The proliferation of smartphones, defined as mobile phones providing more than basic calling services, including access to the Internet, offers another avenue for collecting geospatial data. That avenue is a smartphone application, which is a new form of mobile and web-based technology that provides a specific service to users such as budget tracking, route planning, and delivering news. Smartphone applications have the capability of geospatially tracking users in real time. The different ways and reasons why people use location-based applications have been extensively researched (Barkuus et al, 2008; Boyd, 2004; Joinson, 2008; Lampe, 2010; Lindqvist, 2011). A location-based application is one that uses geospatial data to inform content delivery to the phone user. For example, the location-based application RocketMan delivers bus stop scheduling information to the phone user by locating the user's position on a map in real time as well as the nearest bus stops.

There are three layers of participation – the game layer, the social layer, and the narrative layer – in smartphones, which creates multiple incentives for individuals to engage with location-based applications (Carusa et al, 2011). The game layer is about engaging users to have fun and do something as described by a set system in which the users are players participating in an artificial conflict, defined by rules, that results in quantifiable outcomes (ibid). The social layer allows users to share their spatial experience with other users, including pre-existing personal connections as well as strangers, which strengthen their feelings of belonging to certain communities. The last, and most abstract, layer, the narrative layer, is about self-expression and story-telling. For example, *Foursquare*, with an estimated five million users, describes itself simultaneously as a game, a way of exploring physical areas, a way of telling friends your location, and a way of tracking where your friends have been and with whom they have co-located. The success of similar applications such as *SVNGR*, *Whai Whai*, and *Broadcastr* demonstrate the public's willingness to use location-based applications despite fears of surveillance and infringements on privacy.

Many applications have built-in features that identify and collect both user and geospatial information. However, like mobile networks, applications are owned by private companies, which render obtaining information on the behavior of tourists from existing applications prohibitively expensive, potentially unethical, and may result in inapplicable datasets. Mobile phone networks and social media applications such as *Facebook*, fearing the loss of public trust and subscribers, have incentives to refrain from releasing geospatial data.

Creating a smartphone application with a software development framework that mines the desired datasets can overcome the difficulties presented by accessing mobile phone operators logs and mining data from existing smartphone applications. There is a multitude of location-based smartphone applications specific to tourism that provide tourists with information and perks such as special discounts, augmented reality, and audio walking tours. Prince Edward Island, Nova Scotia, and Alberta are examples of some of the Canadian provinces with social media applications intended to enhance the tourists' experience. However, these applications are focused on distributing, rather than collecting, consumer information.

Due to the widespread adoption of location-based tourism applications, there is a growing body of research on how to build better location-based services for users (Curran & Smith, 2005; Kenteris, 2011; Gretzel, 2011; Martin-Serrano et al, 2011; Heipke, 2010; Werthner & Klein, 1999). However, this body of research focuses on improving the consumer experience rather than harnessing, for planning purposes, the data that could be generated by these applications. Researchers in Estonia and Australia are forerunners in capturing the tracks of tourists using mobile positioning data in order to improve tourism strategies and infrastructure (Ahas et al, 2007; Edwards, 2012).

7.0 CASE STUDY: ESTONIA & MOBILE PHONE OPERATOR LOGS

Dr. Rein Ahas, a professor of human geography at the University of Tartu in Estonia, has pioneered the mining of data from mobile phone operator logs for a number of uses including GIS mapping to inform tourism infrastructure investment decisions. His spin-off company, *Positium LBS*, has ten years of experience working with mobile phone operators in countries such as Estonia, Finland, and Austria. *Positium LBS* is responsible for developing the software data management systems that segments, maps, and analyses the mobile positioning data.

An example of a project by Dr. Ahas includes the Estonian project on strategic regional tourism planning. Dr. Ahas and his research team obtained the roaming data of foreign mobile phones from the Estonian Mobile Telephone network for a period of seventeen months. The data included 12.8 million call activities of 1.2 million MAC addresses from 96 countries, which were mapped for space-time behavior and seasonality of tourist flows. The MAC addresses allowed the researchers to identify typical seasonal routes taken by tourists of specific nationalities, which the Estonian Ministry of Economic Affairs and Communications used to improve way-finding signage, seasonally specific transportation options, and investments in specific attractions such as national parks.

Dr. Ahas and his team of researchers concluded that collecting mobile positioning data has many advantages: data can be collected for larger spatial units and in less commonly visited areas; spatial and temporal preciseness is higher than for regular tourism statistics; the duration, frequency, and seasonality of repeat visitors can be observed (Ahas et al, 2007; Kuusik et al, 2009). The conclusions from this research were used in Estonia to set regional objectives for tourism investment programs (ibid).

7.1 INTERVIEW: DR. REIN AHAS

Questions for this interview centered on the negotiations process for getting mobile positioning data from the mobile phone operators.

The biggest challenge of mining data from mobile phone operator logs is gaining the trust of the mobile phone operators, which is required to gain access to the data. In this regard time is more important than money; the researchers must build up trust over time in order to advance with bigger projects (Ahas, 2013). Dr. Ahas stated that a monetary incentive is an insufficient rationale for mobile operators to participate in such studies and that they would be likely to react negatively to such a value proposition (ibid). The mobile phone operators have two primary concerns when it comes to data sharing: the potential changes in public opinion about their company as well as exposing too much information to their competitors.

Dr. Ahas has stated that there is always a portion of the public that will respond to learning about GIS data collection with anger, fear, and concerns of spying (Ahas, 2013). For example, researchers in Holland used GIS data from *Tom-Toms* (portable personal navigation devices) to map where the most dangerous routes on highways were due to drivers going over the speed limit and then installed new traffic cameras at those locations to lower the number of speeding drivers. The Dutch public reacted negatively to the idea that “they were being spied on,” tarnishing the public image of *Tom-Toms*, which is still recovering in the Dutch market (ibid).

To reduce the scale of negative public reactions, Dr. Ahas recommends developing a public relations strategy that clarifies the purpose, benefits, and data anonymity of any mobile positioning data-related project. Part of the public relations strategy is building a culture of transparency, where the details of each project are nationally discussed through newspaper articles and television interviews. In the Estonian case, it was important to relate the projects back to the European Union’s larger scale statistical analysis projects (ibid).

Mobile operators make a large portion of their revenues from roaming charges and are thus conflicted about making these data public because they do not want their competitors to determine how much of the foreign visitor market they are capturing by releasing these data (ibid). They are also concerned that competitors will initiate smear campaigns that propagate the idea that the mobile operators are spying on the public. In order to alleviate those fears, it is important to begin with a small-scale project that includes a detailed public relations campaign, in order to build towards bigger, more elaborate projects (ibid).

In conclusion, data harvesting from mobile operator phone logs is a lengthy process that requires building institutional trust between researchers and the participating phone company as well as mitigating the possibility of negative public opinion backlash through public relations campaigns. The best advantage of this process is its thoroughness in capturing a wide net of tourists. The data captured can also be used in a wide variety of other applications. For tourism infrastructure decision-

making, this high quality data can demonstrate typical seasonal routes of tourists of specific nationalities, which improves the value proposition for attracting investment and planning for regional tourism strategies among other initiatives.

8.0 CASE STUDY: AUSTRALIA, GIS, & SMARTPHONE APPLICATIONS

Researchers Dr. Deborah Edwards and Tony Griffin have been working with Destination New South Wales, the tourism bureau for the region, in partnership with University of Technology, Sydney to develop new ways of harvesting data from mobile phones. The aim of this research is to gather data to help encourage optimizing the geographic distribution of the tourism dollar, to encourage tourists to extend their stay, and to encourage tourists to travel to the rural areas of New South Wales (Edwards, 2012). These data will be used to help Destination New South Wales to improve regional product and servicing options, improve way-finding for visitors into regional areas, and increase tourist satisfaction levels with the hopes of extending the length of stay and creating repeat visitations.

The project began with the researchers giving willing tourists a hand-held GPS device that tracked the direction, time, location, and pattern of their movements over a single day in either Sydney or Canberra. The major limitation at this stage of the project was eight-hour battery life of the device, which limited the amount of data that could be collected. The researchers concluded that accuracy and detail of data with respect to routes taken as well as the time spent in different attractions and locations far exceeded any information that can be gathered through travel diaries or post-travel surveys (Edwards, 2009).

8.1 INTERVIEW WITH DR. DEBORAH EDWARDS

This interview centered on the upcoming, unpublished research regarding Dr. Deborah Edwards and Tony Griffin's two methods of harvesting geospatial data from social media applications.

For the second stage of the project, the researchers developed a smartphone application called *UTS Tracker*, which tracks how and where tourists are traveling around New South Wales. Besides geospatial tracking, the application delivers mini-surveys at attractions to gather qualitative feedback from tourists such as the transportation used, way-finding to and around destinations, and levels of satisfaction with tourism services and products. Destination New South Wales contributed \$17,000 AUS and in-kind support to the development of this stage of the project (Edwards, 2013).

The lengthy smartphone application development process took over six months, spanning from June 2012 to December 2012, which frustrated both the researchers and the tourism bureau (ibid). According to Dr. Edwards, the first complication was deciding whether to develop the application on an Android platform, an iPhone platform, or investing in developing applications for both platforms. Developing applications for both was determined to be prohibitively expensive by Dr. Edwards and her team. Because market research showed that the majority of smartphone users had Androids rather than iPhones, the social media application was developed for the Android platform.

The second complication with regards to developing a social media application was finding willing tourists with the appropriate phone platform to download the application and participate in the study. Dr. Edwards and her team found that when soliciting tourists to participate in the study, the majority of willing participants had iPhones rather than Androids. This resulted in too few participants to be statistically useful (ibid).

Dr. Edwards and her team have now advanced to a third stage of the project, where they will mine existing social media websites that collect geospatial information. In 2013 the researchers will be asking participants to give them access to their *Facebook* accounts by 'friending' them, which allows the participants to determine the amount of content the researchers can access. The researchers will then ask the participants to 'check-in' on *Facebook* when they are at tourism sites as well as answer daily surveys about their satisfaction levels regarding tourism products and services. By using *Facebook* as the conduit, the researchers may be able to access a wider pool of willing participants (ibid). The participants may be more likely to participate because of their existing knowledge of and comfort levels with the social media platform. Furthermore, *Facebook* can be accessed on all smartphone platforms, thus eliminating the prior problem of platform compatibility. It is important to note that there may be an age selection bias in this step of the process, which the researchers hope to overcome through their selection of recruitment sites such as campervan and hire car companies (ibid).

The tourists' cost of participating in this third stage of the project is negligible as the researchers encourage the participants to log on to their *Facebook* accounts only when open WiFi networks are available – thereby negating the personal costs of using phone plan data. The cost to date of the overall project is \$37,000 AUS, which was funded as a partnership between the University of Technology in Sydney and Destination New South Wales.

Dr. Edwards stated that going forward, her research team will continue to use the Android social media application as well as *Facebook*. They will be collecting geospatial data as well as data about the tourism experience including:

- Locations visited;
- Method of transportation to and from physical locations;
- Barriers to way-finding;
- Satisfaction or dissatisfaction with their experiences.

According to Dr. Edwards, Destination NSW will be applying the knowledge gained from the study in a number of ways. First, Destination NSW will host more practical educational workshops for tourism operators in the region on tourist feedback and on how to improve the tourism product and services. Second, Destination NSW will use the geospatial information to make better evidence-based investments to inform subsequent efforts to improve visitor information services, way-finding, and transportation methods from metropolitan to regional areas. Third, Destination NSW will be able to better target marketing messages to their tourist audience through traditional means of advertising as well as through social media applications.

In conclusion, harvesting data from existing social media sites may be the most affordable and time efficient method for gaining some perspective about tourist geospatial flows and levels of satisfaction. Comparatively, developing a social media application from scratch may require more time and funding (although not as much time as mining from mobile phone operator logs). The difficulty of the social media application method is in offering incentives to recruit willing participants. Both of these methods capture fewer tourists than mining mobile phone operator logs does; however, they have the advantage of collecting rich qualitative feedback on tourists' levels of satisfaction, thereby delivering more meaningful information about a particular market segment and their spatial engagement within a destination. They also have the advantage of requiring less time and funding than mining from mobile operator phone logs.

9.0 INTERVIEW WITH ELI PERELL, ONTARIO MINISTRY OF TOURISM, CULTURE & SPORT

This interview focused on how geospatial data harvested from cell phones could be of use to the Ministry of Culture, Tourism and Sport.

Eli Perell, a Senior Policy Advisor to the Tourism Policy & Research Branch at the Ontario Ministry of Tourism, Culture and Sport, discussed the Ministry's interest of obtaining more in-depth information to build the case for investment in the Ontario tourism industry. He stated that improving the granularity of the existing data would support existing Ministry efforts. The Ministry would like to be able to determine to which specific destinations tourists are going; being able to create heat maps of regional areas would be an ideal outcome (Perell, 2013). Heat maps are graphical representations of data that use different colors to indicate different levels of activities. The heat maps, and other data-rich products produced by geospatial data collection, would aid the Ministry in achieving two of their strategic priorities: to obtain better information and evidence to support regional tourism marketing as well as to attract foreign investment into Ontario tourism attractions. Data harvesting from mobile phone operators logs has the capability to produce incredibly accurate heat maps among other graphic, data-rich products.

Mr. Perell confirmed that the Ministry has a great interest in learning more about these methods of data collection, especially as cell phones and smartphones become increasingly prevalent throughout the population. The Ministry is aware that there are many important considerations when investigating this technological area, including privacy (Perell, 2013). By beginning research in this field now, the Ministry has the opportunity to become a leader in the field of technology and tourism planning.

10.0 FINDINGS

There is a clear gap in the datasets that the Ontario Ministry of Culture, Tourism & Sport uses to create policy, evaluate development plans, and fund projects. There are multiple methods that the MTCS could implement in order to better determine the geospatial movements of tourists throughout the province as well as better evaluate the tourists' levels of satisfaction with tourism products and services. This would improve the granularity of the MTCS's datasets as desired by Ministry officials in order to fulfill their strategic objectives of increasing private sector investment, expanding markets, and creating more effective marketing strategies (Oakes, 2013).

The most comprehensive method of tracking tourists' geospatial movements would be to gain access to mobile phone operator's logs. This would be a lengthy process requiring a partnership between the private mobile operator companies and government researchers. The data would capture the movements of all tourists with foreign-registered phones, allowing researchers to correlate the phone's national identity with that of the tourist's nationality. The data would also capture the movements of out-of-province tourists by identifying the origin of each tourist using their mobile phone's area code. All data would be made anonymous through software processes. To reduce public fears of spying a comprehensive public relations campaign explaining the purpose, benefits, and anonymity of the project would be implemented. Building institutional trust – between the mobile phone operators, government researchers, and the public – over time would ensure the ongoing success of this process. The limitation of these data is that mobile phone operator logs only track tourists' geospatial movements with no opportunity for evaluation of tourism products and services. However, it is the most comprehensive of all three options because it can capture the movements of all tourists with a mobile phone or a smartphone.

The most efficient method – in terms of time and cost – would be to create an Ontario specific smartphone application for both iPhone and Android users. The biggest limitation of this option is that the data collected would be skewed because the investigators can only collect information about tourists who are smartphone users. The biggest obstacle of this option would be marketing the smartphone application to encourage its use over all the other existing smartphone applications related to tourism in Ontario such as *Discover Ontario* by the Ontario Tourism Marketing Partnership Corporation and *Ontario Museums* by the Ontario Museum Association. Mining those existing applications for data on tourists may be a viable option, depending on how the application collects and stores data. Mining existing applications – Ontario tourism-related applications as well as popular social media applications such as *Facebook*, *Foursquare*, and *Twitter* – would require lengthy legal negotiations, is potentially unethical without the consent of users, may be prohibitively expensive, and may result in inapplicable datasets. Mining existing applications for data is associated with many risks and difficulties, which is why it is not recommended by this report.

Comparatively, creating a new Ontario tourism-specific application would allow the MTCS to ensure that it is collecting the desired the datasets as well as to facilitate better cooperation and information sharing among Ontario tourism stakeholders. It would require much less time than gaining access to mobile phone operators logs and overall it would be more cost-efficient. The costs associated with accessing the mobile operators' logs include legal contracts, a public relations campaign, and staff time for negotiations, software development, and analysis. Comparatively, the costs for creating a smartphone application include software development contracts, consulting tourism-related stakeholders, and a marketing campaign. Overall, the data produced by mobile phone operator logs are the most comprehensive, but also the most expensive with the longest time frame before seeing returns.

Of course, both of these avenues require tourists to own either mobile phones or smartphones, thus excluding tourists without either mobile phones or smartphones. This would apply to many foreign tourists who may purchase a pay-as-you-go smart chips for their phones (which give them a local phone number), who may not use a mobile phone during their travels, or who do not own either a mobile phone or a smartphone. However, as mobile phone and smartphone popularity continues to grow and prices decrease, it is reasonable to think that most Canadians travelling within the country would bring and use their mobile phones on their trips through Ontario. The increase in usage of mobile phones and smartphone applications by international tourists may be on the same trajectory. Harvesting mobile positioning technology from smartphones and other geo-capable devices is a practice that is certain to become regular practice – the MTCS has the opportunity to become a leader in this field specifically related to tourism infrastructure planning.

11.0 RECOMMENDATIONS

The first recommendation is to develop a small-scale project (in terms of both scope and length of time for implementation) in order to begin to build a working relationship with a mobile phone operator company. For example, analyzing all the area code data from antenna towers in near proximity to Caribana parade to determine the regional origins of the visitors to Toronto for the purpose of attending Caribana would be a small-scale project that could be used for informing and improving the effectiveness of marketing strategies.

The second recommendation is to initiate the development of an all-encompassing smartphone application for tourism in Ontario. A project lead with a solid knowledge of stakeholder building, software programming, and marketing would be ideal. The first step would be to develop a sophisticated stakeholders engagement strategy in order to ensure that the needs of tourism stakeholders are being met, to streamline content generation and delivery, and to develop the data structure of the application. The organizational structure of the social media application can be developed through stakeholder consultations and put into practice by professional software coders. Lastly, the user-friendly interface (what the tourists see on their mobile phone screen) can be developed in collaboration with graphic artists, the software coders, and the Ministry with input from stakeholders. It is critical to keep the end-user in mind, ensuring that the application is convenient to use and that the incentives to use it are appropriate.

In conclusion, the wealth and quality of data being produced by mobile phones and smartphones is an opportunity that can be taken advantage of by the MTCS to improve the granularity of their data by obtaining tourists' geospatial movements. Furthermore, there is opportunity to obtain more specific feedback from tourists on the evaluation of tourism products and services. There are three precedents for using mobile positioning data to improve decision-making regarding tourism infrastructure: data mining from mobile phone operators logs; data mining from existing smartphone applications; and, developing a new smartphone application for the specific purpose of collecting consumer information with geospatial data and evaluation feedback. Data mining from mobile phone operator logs is the most comprehensive option while creating a new smartphone application is the most cost efficient and will produce the fastest returns on investment. Overall, the viability of mining data from mobile technology is highly applicable in the Ontario context, especially for the purposes of improving decision-making in the tourism industry related to attracting investment, expanding markets, and improving the effectiveness of marketing campaigns.

12.0 APPENDIX A: INTERVIEW QUESTIONS

Estonia - Questions for the researchers:

- Are there any additional advantages to collecting mobile positioning technology besides those discussed in the study?
- What were the disadvantages to this data collection method?
- Do you think this research method will be repeated again, several years down the road? For example, to determine whether tourist origins, destinations, and seasonal patterns have changed?

New South Wales - Questions for the researchers:

- What stage of the research project are you in?
- What different types of data were you able to collect via the smartphone application?
- What are the advantages of the smartphone application?
- What are the disadvantages of the smartphone application?
- Were there issues with the original design of the application? How were they overcome?
- Has the data collected been useful for Destination NSW?
- Will the data collection continue? What are the next steps?
- What have you learned from the data regarding your objectives of getting people to visit the region outside of the urban centres?

Ontario Ministry of Tourism, Culture and Sport – Questions for the public officials:

- What sources of data does the ministry use to understand tourists' behaviour? For example, seasonal tourism, where they go and when they go, levels of satisfaction?
- What are the current sources of data used to make tourism infrastructure investments? Does the Ministry make these kind of investments? (For example, transportation and way-finding)
- What are the limitations of the current sources of data?
- Would it be beneficial for the department to have access to the kind of data used in Estonia or New South Wales?

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