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ALI, Alisha <<http://orcid.org/0000-0002-7667-4293>> and FREW, Andrew J.

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Technology Innovation and Applications in Sustainable Destination Development

Alisha Ali, Sheffield Hallam University
Andrew J. Few, Queen Margaret University

Abstract

This paper introduces information and communication technologies as an innovative approach to managing sustainable tourism development from a destination management perspective. Specific attention is focused on the how destination managers utilise the various forms of technology in addressing both the positive and negative impacts of tourism. Building on Hjalager's (1997) analytical typology for sustainable tourism innovation, this research aims to advance tourism innovation research and demonstrate new uses of technology and the wider applications for sustainable tourism. Using a thorough literature review and primary research with destination managers, a collection of technology based tools and their uses were examined for sustainable tourism development and how these tools can foster destination innovativeness.

Keywords

ICT, information and communication technology, sustainable tourism, eTourism, innovation, destination management

1 Introduction

Tourism's phenomenal, sustained growth rate makes it highly attractive as a means of economic development (Mihalic et al. 2012) and like most commercial activities, tourism has produced both beneficial and detrimental environmental and socio-cultural impacts, some of which may be irreversible. Balancing economic growth with protection of the environment is a challenge, which today faces most tourism professionals and the tourism industry is focusing on sustainable tourism development (ST) as a mechanism to try to achieve the aims of economic development whilst protecting, preserving and enhancing the environment (Swarbrooke 1999).

Destinations are inevitably the areas where the main tourism impacts occur are felt most powerfully (Wall and Mathieson 2006) and there has been a general and growing concern on how destinations can develop in a sustainable manner (Dodds 2012). A plethora of ideas, techniques and philosophies have been developed to both explore and explain ST (Swarbrooke 1999). Some examples of these approaches include indicators, monitoring, eco-labelling, codes of conduct and alternative forms of tourism. However, many of these approaches have been documented as having a "lack of quality, technical content, reliability, maturity, equity and effectiveness" (Van Der Duim and Van Marwijk 2006: 449). Despite more than 40 years of tourism research focusing on ST and its implementation (Mihalic et al. 2012), the case is still considered theoretically weak (Moscardo 2008; Sharpley 2010). Pigram's (1990) and Liu's (2003) arguments that ST research has to progress beyond the formulation and discussion of the principles and assumptions to effective solutions is still at the crux of the debate today. Added to this, tourism businesses find it difficult to understand and apply sustainability practices (Mihalic et al. 2012) whilst Sharpley (2010) debates that the notion of sustainable tourism is indeed a myth which prevents ST from becoming a practical reality. Therefore challenges still exist to find viable ways of translating ST into practical actions for the tourism industry.

The aim of this paper is to explore, develop and endorse an alternative approach for ST. It supports the proposition that ST can become an effective concept in destination management through the innovative applications of information and communication technology (ICT). The nature of this exploratory study is such that full generalisability is not claimed, however, the work complements prior research the ICT-ST domain and provides deep insight into perspectives from which wider ramifications can be drawn. ICT is an inclusive term that refers to any product that store, retrieves, manipulates, transmits and receives digital data and how these differing applications work with each other, but it is only a tool, and it still requires interpretation for its applications to be actionable. The use of technology in tourism is not new, rather the tourism industry has been influenced by increased applications, growth and widespread use of ICT and it continues to be one of the greatest influences fuelling change within tourism (Buhalis and Law 2008). The exploitation of ICT specifically to support the management of sustainable tourism has been an underexplored area in tourism research. Melville (2010), Dao et al. (2011) and Bajracharya et al. (2013) have all commented that a research gap exists which focuses on the role of technology for developing businesses capabilities for sustainability. Watson et al. (2010) further argues that it is the responsibility of scholars to focus some of their research on providing a greater understanding of how technology can help to alleviate sustainability concerns while Henry (2012: 142) noted that, "it would seem foolhardy not to understand the ICT implications in these regard".

Adopting a destination management perspective, this research identifies the linkages between technology, innovation and sustainable tourism. Destinations are not only a widely accepted organising unit in tourism and the attracting power for tourists; they are the central point for all the stakeholders in the tourism industry (Ko 2005; Bornhorst et al. 2010). Within the constraints of such an exploratory study, the authors nonetheless

contend that this paper usefully contributes to theory by expanding the uses of tourism innovation theory and adds to knowledge by expounding the applications of ICT for sustainable destination development.

2 Literature Review

2.1 ICT for Sustainable Tourism

Sustainable tourism has its wider foundations upon and an intimate relationship with the concept of sustainable development (Bramwell and Lane 1993; Hardy and Beeton 2001). The Brundtland Report produced the most widely used definition of sustainable development as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development 1987: 43). A destination can be considered sustainable if an appropriate balance is achieved in the environmental, economic and socio-cultural aspects of tourism development (Edgell 2006), underlining the triple-bottom line approach. Notwithstanding the numerous debates in the literature, the concept of ST had provided a unified platform where tourism stakeholders can “interact, negotiate, and reflect on their actions’ consequences for the environment” (Saarinen 2006: 1124). Progress has been made in effecting ST and Table 1 identifies the key concepts, which have been used by destinations for achieving this.

Table 1. Concepts for Managing Sustainable Tourism Development

Concepts	Description	Main Objectives in Sustainable Tourism	Examples of Tools used
Carrying Capacity	The amount of visitors a destination can tolerate without impacting negatively on the environment, the local community and the visitor experience	Prevention of environmental degradation	Visitor management techniques such as queues, reservations, lottery, pricing, timed entry, zoning, permits and setting up of protected areas
Government Intervention	Mandatory measures imposed by a central authority to reduce environmental degradation	Pollution prevention and control	Legislation and licensing
Economic Approach	Instruments such as taxes and financial incentives are used to persuade tourism businesses to engage in more sustainable activities	Pollution prevention and control and the encouragement of sustainable practices	Taxes
Self-regulation	Tourism industry taking responsibility for its own action	Pollution prevention and control and the encouragement of sustainable practices	Codes of conduct Awards
Education	Educating the tourist on developing and displaying more sustainable behaviours at the destination	Encouraging sustainable consumption patterns	Codes of conduct
Monitoring	Developing goals, objectives and expectations for an identified issue and continually assessing this issue against this baseline	Provide a clear measurement of progress, updated information and enhanced knowledge	Indicator development Eco-labelling
Marketing and Information Services	Destinations market segment in order to attract the types of tourists they want	Promote particular forms of tourism, influence tourist’s behaviour, promote product offerings and reduce seasonality by promoting off-season opportunities	Marketing and de-marketing
Environmental Management	Determining the optimal allocation of resources that will make best use of the environment and fulfil the needs of the users for a set time period and improve the quality of the environment.	Environmental objectives are integrated into the tourism policy and planning	Visitor management techniques, taxes, monitoring

Adapted from Ali and Frew (2013)

Despite this progress, there is still a necessity for workable solutions in implementing ST. Henry (2012) commented that the greatest hope for sustainability would be through the use of ICT. In the literature, one area that has not been thoroughly investigated is the possibility of using ICT as such an innovative approach to mitigating tourism's negative impacts and highlighting its positive consequences. The use of ICT and especially the Internet have changed the way in which information is collected, stored, distributed, processed and managed in tourism. For destinations, it serves as a mechanism for new distribution channels and increases communication and interaction with and between stakeholders (Gratzer et al. 2002; Buhalis and O'Connor, 2006).

There has been some preliminary progress in investigating the ICT-ST domain. For example, Ali and Frew (2010; 2014) theorised and tested how ICT can be innovative for ST through use of the Abernathy and Clark (1985) framework. Mohammed Shafie et al. (2013) presented a conceptual approach in understanding how ICT capacity can be used in sustainable urban tourism through ST indicator development. Using Åre in Sweden as a case study, Fuchs et al. (2013) presented a knowledge-based destination management information system, which can aid in sustainable destination development. Chiabail et al. (2013) focused on facilitating stakeholder participation for sustainable cultural tourism development through the design of a Website, which used tools such as blogs and forums in Genoa, Italy and Asafe et al. (2013) concentrated on how ICT can be used for ST in Nigeria from a safety and security perspective. Ali and Frew (2013) have presented a holistic overview on the ICT-ST field by conceptualising it from a destination, consumer and business perspective and derived a collection of ICT-based tools for ST as presented in Table 2.

Table 2. Summary of ICT-based Tools and uses for Sustainable Tourism Development

ICT-based Tools	Definition	Uses for sustainable tourism
Carbon Calculator	Used to determine carbon emissions based on the type and amount of energy consumed.	Emission monitoring for cleaner environment benefit for visitors and local community. Destinations may be able to attract the environmentally-conscious traveller leading to economic benefits.
Community Informatics	Focuses on the design and delivery of online electronic media to enhance community engagement.	Facilitates increased community participation in the decision making, empowers individuals, strengthens community identity and creates economic development opportunities
Computer Simulation	A simulation of real world settings where models are designed to depict how systems operate over time.	Issues too complex for direct observation, manipulation or mathematical analysis are simulated to investigate the effectiveness of alternative management practices. This leads to better decisions on impacts on the economic, natural and socio-cultural environments with realistic scenarios available to engage all stakeholders including tourists, planners and the local community.
Destination Management System	A system that consolidates and distributes a comprehensive range of tourism information and products through a variety of channels and platforms	Facilitates the establishment of platforms for promoting economic benefits for the local communities, reducing socio-cultural tensions and negative impacts and can highlight fragile ecosystems at destinations. DMS may also enhance tourist engagement and satisfaction levels through relevant readily accessible destination information.
Economic Impact Analysis Software	Software used to monitor the economic impacts of tourism by providing information on the type and amount of spending.	Information can be used to determine financial feasibility, choose among alternatives, increase the level of economic activity and lobby public support for tourism development.
Environment Management Information Systems	Computer systems which integrate disparate environmental information sources in order to facilitate organisational management.	Environmental data such as tracking, waste monitoring, emissions and cost/benefit assessment are analysed for better economic, natural and socio-cultural decision-making.
Geographical Information Systems	Information systems that can capture, store, manage, manipulate, analyse, integrate and display large	Indicators for sustainable tourism can be identified, defined and measured. Information provided for modelling and evaluating appropriate locations for

	amounts of geographical data.	proposed development
Global Positioning System	Satellite-based navigation system that provides positioning, navigation and timing services to users in any weather conditions around the world 24 hours a day.	By planning spatio-temporal distribution of tourists via movement tracking, impacts on the environment can be managed and minimised
Intelligent Transport System	Telematic systems, which provide detailed information on traffic, information from independent locations, traffic guidance and dynamic routing.	Improved ground transport systems allow tourists to be more aware of their travelling options at the destination leading to wider usage of public transport which also benefits the local community by reducing traffic congestion at the destination and host-tourist antagonism may also decrease.
Location Based Services	Collects and delivers information to and from a mobile device depending on the automatic location of the user. Targeted information is provided to the user based on his/her geographic location.	Location-sensitive information can be sent to the tourists to raise awareness and familiarise them with e.g. the culture, heritage and customs of a destination and enhance the likelihood of making sustainable in-trip choices. Additionally, information can be provided on promotions, places to visit, accommodation and other general information such as safety and security and weather. This may raise tourist spend and overall has a positive impact through print reduction.
Tourism Information System	Data warehouses that manage business critical information in order to provide quality information on hand to assist in decision making by serving as a decision support system for destination managers	More high quality information is on hand to assist in decision making by serving as a decision support system for destination managers
Virtual Tourism	Based on the Internet anyone can experience the culture, history and other points of tourist interests in a visual and interactive manner without actually visiting the destination.	Virtual tours may act as a full or partial substitute for destinations that have exceeded their carrying capacity or are fragile in some way e.g. through substituting for activities may be regarded as socially unacceptable, reducing traffic impacts etc.
Weather, Climate and Ocean Change Forecasting Software	Software used to monitor changes in the weather, climate and ocean.	This information can be useful for bidding for events, making decisions about proposed development, putting measures in place for hazards and risks associated with bad weather, provide tourists with updated information, energy management and other issues.

Adapted from Ali & Frew (2013)

2.2 ICT, Innovation and Sustainable Tourism

Engaging in innovative behaviours is critical to any industry seeking to achieve its full potential, and tourism is no exception. Hall and Williams (2008) commented that tourism could be a commanding force for driving and transmitting innovation. Research in tourism innovation is, however, limited, sparse and fragmented (Hjalager 2005) and a gap still exists in demonstrating the significance of how tourism innovation can be executed in practice (Hjalager 2002). Despite the growth of the literature in tourism innovation in recent years (see Hjalager 2010 for an overview of tourism innovation research) research is still necessary, as very little emphasis has been placed on the application of ICT as an innovative approach to ST for destinations.

Technology and innovation have huge importance in fostering a greener, low-carbon economy (Bartlett and Trifilova 2010) and both technology and innovation are the main forces for ensuring sustainability (Scheel 2011). ICT has been deemed essential for innovation (European Commission 2009). Hjalager (2010) reinforced this when she identified ICT as an important catalyst for tourism innovation whilst Racherla, Hu and Huyn (2008) argued that destinations have not embraced the power of ICT to connect with innovation for tourism planning and development. This current work seeks to combine both, by looking at how ICT can be an innovative activity for the tourism industry.

Innovation research is usually developed from Schumpeter's (1939; 1942) work, which is rooted in economic theory and accentuates that innovation is linked to competition. The innovative idea has to be fused with a product, process or service for specific industry uses. The word "newness" is often closely aligned with

innovation but it does not have to be totally new but rather only new to the market or the industry to be considered innovative (Sundbo 1998). ICT is not new to tourism but rather can be argued that its applications to ST are new. This research views innovation as a creative, problem-solving approach and a new way of thinking for the tourism industry (Moscardo 2008).

Hjalager (1997) developed an analytical typology for ST innovation comprising the dimensions of product innovation, classical process innovation, process innovations in information handling, management innovation and institutional innovation. This paper argues that ICT-ST can be aligned to the categories of innovation identified by Hjalager (1997) as discussed below. Product innovation consists of changing, combining or introducing a new tourism product or service, where the novelty is more attractive to the tourists. With ICT-ST, a product innovation would be the development of different types of ICT for use by tourists to be more sustainable in their activities during all trip stages. Process innovation refers to raising the performance level through the redesign of the production and delivery systems with the aim of achieving savings in production inputs such as labour (Hjalager, 1997). This category of innovation would occur when technology is used for managing the natural, economic and social-cultural resources of a destination. Process innovation for information handling refers to using ICT for managing information. ICT can play an invaluable role in ST through the efficient management and monitoring of environmental information at the destination.

Management innovation refers to new management procedures, which change the existing authority systems, creating new jobs and collaborative structures and staff empowerment (Liburd 2005). New roles in Destination Management Organisations (DMO) will be defined, as ICT will change the way destinations are currently operated. Institutional innovation lies beyond the individual enterprises as collaborative processes or regulatory structures that transect the public and private sectors. This type of innovation is more wide-ranging than those discussed prior since institutions not only exist in a physical state, but also are habits and customs and provide some type of framework within which people can interact (Hjalager 1997). The tourism system will have to be managed by an institution that is located beyond the scope of individual businesses and organisations (Hjalager 1997). The use of ICT-ST can stimulate this type of innovation by fostering better partnerships with stakeholders and engaging in dialogue with the community.

Classical innovation theories have much to offer tourism but there has been limited research on these applications (Hjalager 2002). It has been argued that tourism innovation is usually an application of innovation from other sectors (Camison and Monfort-Mir 2012). Employing Hjalager (1997) typology and building on the work of Ali and Frew (2013) this research will make evident that ICT can be an innovative and practical approach for destination managers in their endeavours to further support ST. It will also contribute to the literature on tourism innovation theory, identified as a research gap (Hjalager (2010)). Therefore the research questions answered are:

1. What ICT-based tools are being used by destinations and how are they being used for sustainable tourism development?
2. How do destination managers view the future uses of these ICT- based tools for sustainable tourism development?
3. Do destination managers consider the use of such ICT-tools innovative and how would they categorise their innovative uses for the sustainable tourism development?

3 Methodology

Based on the limited extant theoretical and empirical research on the applications of ICT-ST for destination managers, an interpretivist perspective was selected as the most suitable approach for this research. This is because the inventiveness of ICT tools to ST as a research field and exploratory nature of this study aligns itself to a more flexible and open research design rather than one that was highly structured and rigid. Destination managers were drawn on since they are usually the key players charged with the responsibility for the holistic planning and management of tourism and in essence, the sustainability of their destinations. The superset of potential tools for consideration by destination managers has been established in the literature as evidenced above.

It is important at the outset to define key terms so that it is clear what is being researched, for whom and from which perspective, and these are destination, destination management organisation and destination manager. A destination is defined as the physical space/geographical area, which contains tourism products and services to be consumed by the tourists as part of the experience and which is managed by an organisation such as a DMO. The DMO will be seen as the organisation responsible for the holistic management of tourism at the destination level, which encompasses a range of tourism development, planning and marketing activities whilst the destination manager will be the person responsible for the overall management of a DMO. These DMOs can fall under one of the following categories:

- Continental DMO responsible for the management of tourism in a continent defined for that purpose.

- Regional DMO also known as Regional Tourism Organisations, responsible for the management of tourism in a geographic region defined for that purpose.
- National DMO also know as National Tourism Organisations, responsible for management of tourism of a country.
- Local DMO, responsible for the management of tourism based on a smaller geographic area or city/town.
- Local attraction DMO responsible for the management of tourism based on an attraction or local feature of a geographic area or city/town.

It is well understood that destinations exist which are not "managed" by a DMO. A Government Ministry, a local body, a public-private partnership or some other type of management arrangement can manage these destinations. The person(s) charged with the responsibility of managing these entities can indeed be identified as destination managers. Different classifications of destination managers do exist outside of the sphere of a DMO. Even though the specific institutional arrangements may vary in countries, almost all destinations have a DMO (Werthner and Klein 1999). For the purpose of this research, the dimensions chosen for investigation needed to be realistic and meaningful and therefore destinations were managed by a DMO, and the person responsible for managing the DMO was the destination manager.

Mixed methods employing an explanatory sequential design (Creswell and Plano Clark 2011) using online questionnaire followed by semi-structured interviews was adopted for this research. Solely using a quantitative or qualitative method would not have provided the necessary information to answer the research questions (Bregoli 2013). Tourism, and in essence ST, is a complicated concept which provides challenges in studying and mixed methods can be used to comprehensively understand this complex entity (Puhakka et al. 2014). In order to develop a holistic understanding of how ICT can be innovative for destinations for ST, this approach was felt to be the most appropriate. These methods complemented rather than competed with each other (Johnson et al. 2007) and the literature has given support to the use of this approach (see Newman 2004; Bryman and Bell 2007; Creswell & Plano Clark, 2011).

These online questionnaires were administered to gain an overall picture specifically on the tools/applications of ICT-ST. The questionnaire was designed in consultation with the literature on ICT-tools for ST and tourism innovation specifically Hjalager's (1997), with these main constructs being operationalised. Table 3 below highlights the main constructs and the operational definition.

Table 3: Constructs and Operational Definitions

Construct	Operational Definition
Awareness	Self reports (asking the person) Types of ICT-based tools being used for sustainable tourism Uses of ICT-based tools for sustainable tourism Ranking of ICT-based tools for sustainable tourism Importance of ICT-based tools for sustainable tourism
Types of ICT	Self reports Types of ICT-based tools being used for sustainable tourism
Current and Future Uses of ICT	Self reports Current use of ICT-based tools for sustainable tourism Future use of ICT-based tools for sustainable tourism
Innovative uses	Self reports How is ICT for sustainable tourism innovative Categorisation of innovation for these ICT-based tools for sustainable tourism

For the surveyed population, a database consisting of destination managers located worldwide was obtained from a leading tourism consultancy. An e-mail was sent to recipients by the head of this consultancy introducing the researcher and the purpose and scope of the research, informing them of the ethical standards applying to the research and asking them to complete the questionnaire. Whilst the questionnaire was anonymised, participants had the option of leaving their e-mail addresses to be contacted for a further discussion. It is acknowledged that there may be destination managers who may not be privy to this database but it was a representative cross-section of destination managers and there were no other comprehensive database. Due to the confidentiality involved in obtaining the database, respondents were not asked to identify their location but rather the type of DMOs they were and the region of the world they were located in.

Four hundred and thirty-four DMOs were contacted and this led to response rate of 9%. This survey response rate of 9% *prima facie* may seem low, however, it must be considered in context of this research. Online surveys have an average response rate of 11% (Weimiao and Zheng 2010) and response rates as low as 3% are reported in highly rated IS journals (Sivo et al. 2006), the detail depends on the context and the robustness of the method. In this case the researchers felt that these response rates were adequate since appropriate measures were adopted to minimise non-respondent bias. Additionally, the populations under investigation were ‘elite’ populations as they were drawn from senior managers responsible for managing tourism destinations. Therefore, the responses must be interpreted in light of the purpose of this research and the findings. The data from the closed questions were coded, entered into SPSS, and analysed using cross tabulations and descriptive statistics since this provided a simple yet rigorous way of arranging the data and presenting the results (Denscombe 2007). Complex statistical analysis was not suited to the data set due to the size of the sample and the categorical nature of the data. The data from the open-ended questions were treated using content analysis to establish key themes.

Not all the information required for understanding ICT uses in ST were available from the questionnaires and further data was needed which was gathered through the interviewing process to gather more specific data relating to the research questions identified earlier. The questionnaires were instrumental in identifying people who were knowledgeable in this area (Bryman and Bell 2007). Based on the responses, it provided the foundation for the type of questions to be asked in the interviews and served as a means of adding validity and reliability to the interview questions. Using the online questionnaires also allowed respondents to be introduced to the topic and become familiar with the type of research that was being conducted so when approached for the interview, they were more willing to participate. The types of questions asked revolved around expounding the uses by destination managers for ICT for sustainable tourism and discussing and describing the innovative applications of ICT for sustainable tourism.

Sequential sampling was used to identify those participants for the semi-structured interviews and they were contacted by e-mail and asked to participate in an interview. This sampling approach was felt to be most appropriate because the selected interviewees would possess greater knowledge about the uses of ICT-ST. Cooper and Schlinder (2003) commented that this approach is most suitable to exploratory research and when the researcher wants to discriminate the type of respondents. Thirteen interviews were conducted using the Skype software and this number was based on reaching a saturation point, when findings of the earlier interviews were being repeated by the later ones and added little benefit to the research (Newman 2004). In the literature it is argued that ten cases are adequate in developing themes and concepts from qualitative data (Eisenhardt 1989). The interviews were analysed manually, with each interview transcribed *verbatim* upon completion. Text based on these common themes were compared and contrasted and further refinement of these themes occurred until key themes were identified which ensured meaning was made of the text. Peräkylä (2005) observed that such an approach is perhaps most appropriate choice in research design where the qualitative text plays a complementary role, rather than being the heart of the research.

4 Results and Discussion

The results of the questionnaire and interviews have been analysed and presented together. Of the thirty-seven DMO that responded with valid data, most (20%) were local DMO, whilst the least were continental DMO (5%) and coastal DMO (5%) as seen in Figure 1.

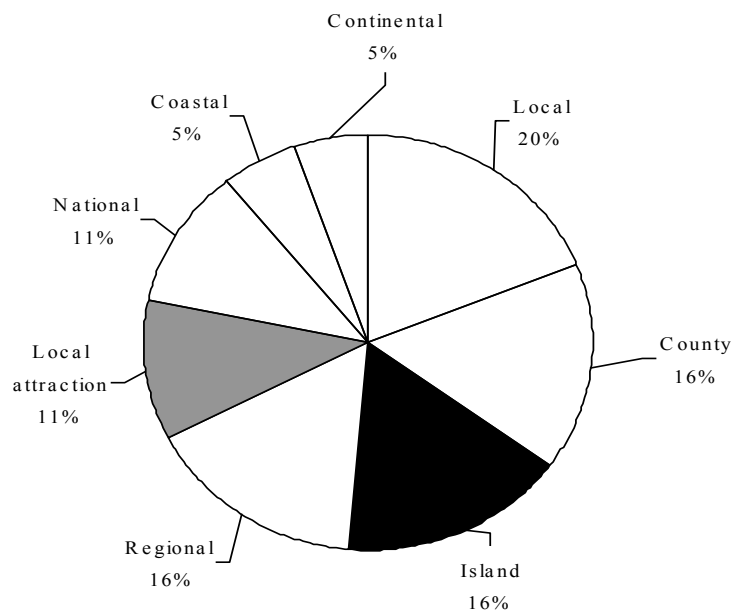


Figure 1. Distribution of the types of DMOs surveyed

Just under half (47%) were located in Europe, whilst about one fifth (19%) were located in Australia and 16% in North America. Most DMO surveyed (38%) were a department of a regional/provisional/state or local organisation. Eleven percent of these DMO operated for profit whilst 11% were a national governmental department and 5% were accountable to a national government.

4.1 ICT Tools for Sustainable Tourism

Five percent of DMO identified that ICT was used universally for ST whilst 11% stated it was not used at all. Most DMO (46%) stated that they used ICT somewhat for managing ST, whilst a little over a quarter (27%) stated that they used it very little and 11% did not use any ICT usage for ST. Destination managers identified a collection of ICT tools that they currently utilise ranked in order of importance (please see Table 4). The Internet (65%) was identified as the most used tool for ST, and was included in the questionnaire as an ICT-based tool/application. After further reading and reflection, the researchers felt that the Internet could not be classified as an ICT-based tool/application since this was the platform on which these ICT tools were based and so was removed from the analysis.

Table 4. Ranking of ICT-based Tools/Applications for Sustainable Tourism

DMO Ranking	ICT-based tools/applications
1	Destination management system
2	Intelligent transport system
3	Environment management information system
4	Location based services
5	Global positioning system
6	Geographical information system
7	Community informatics
8	Carbon calculators
9	Virtual tourism
10	Computer simulation

Unsurprisingly perhaps, Destination Management Systems (DMS) were identified by destination managers within DMO as the most important tool for supporting efforts in sustainable tourism development. The results identified DMS being used for information management (Buhalis 1999), marketing (Horan and Frew 2007), enabling partnerships and information exchange amongst stakeholders (Buhalis and Spada 2000), resource management, distribution, tourist education and satisfaction (Buhalis 1999) and sustainable consumption. Interviewed experts held varying opinions on the uses of a DMS for sustainable tourism that corroborated the survey findings. One expert said it mainly as an economic tool whilst others saw it as playing an important role in educating people about the destination's sustainability policies. Other experts were of the opinion that if it became a "true" DMS and merged with other aspects such as data integration, information distribution and co-operation with small and medium sized enterprises, then it can have great uses for sustainable tourism development as depicted in the observation.

The point of a DMS is that it falls into two parts normally. The one part is that there is the online platform which is used by the customer, and of course there is less use for sustainable tourism. Most of the DMS are in fact online platforms. On the other hand, if it were really a DMS then this would have aspects of a decision support system and things like this where the stakeholders of a destination can co-operate. If this is the case then of course it can be used for sustainable tourism development. For example, the different stakeholders of a destination could exchange information about how to reach sustainable tourism, how to improve the management of the destination and, of course, the DMO can better inform the stakeholders of different policies on how to reach sustainability. If it is really a DMS, it will be worthwhile but if it is just an online platform for informing the customer, of course, there will be less use for sustainable tourism development.

The questionnaire and interviews revealed that Intelligent Transport System (ITS) was deemed to be an important ICT tool identified which was used for tourist satisfaction by providing real time information and traffic management (Diagle and Zimmerman 2004; Sheldon 1997), leading to savings in energy (Erdmann and Behrendt 2003). ITS help tourists to identify the safest and quickest route, assist in navigation and generally enhance the enjoyment of the destination.

Environment Management Information Systems (EMIS) was used for resource and information management (El-Gayar and Fritz 2006), which could lead to cost savings. Labour cost was reduced since manual processes such as measuring waste, monitoring emissions and co-ordinating permits can be automated through the use of the EMIS. Environmental benefits are achieved from using integrated data to make important decisions about tourism planning in sensitive areas by identifying sites and attractions for development (McAdam 1999) and helping with tourist management techniques through zoning and identification of areas that require protection (Bahaire and Elliott-White 1999). Using the metrics generated from the EMIS, destination managers are now more aware of the impacts of tourism at the destination and can therefore take the necessary remedial or mitigating action. This information helps to monitor and measure the environmental quality of the destination as identified in the comment below

We use an EMIS is to identify areas for zoning. For instance we have identified areas of tranquillity, high tranquillity and we would map those against habitat and try to identify no go areas where we want to keep people away to avoid their disturbance of habitat and special parts of the landscape that are delicate. We've also used this system to identify areas where we could generally identify where we would want to keep people out of cars but on bikes.

Location Based Services (LBS) were acknowledged as being very promising for managing sustainable tourism, with a wide variety of uses, including the provision of information to the tourists for visiting geographic locations in real time (Berger et al. 2003; Liburd 2005). It aids in the management of the destination's resources since they can market and inform the tourists about which sites and attractions to visit, educate them on travelling to sensitive areas, how they can maintain the destination's environment and appropriate behaviour at the destination. This information can help tourists make sustainable choices about which products to consume whilst at the destination (Liburd 2005) as seen in the following remark,

If you have an iPhone, it could completely revolutionise the way we talk about information, as mobile devices and smart phones get more ubiquitous. I think in 3-4 years the smart phone is going to be more or less the standard piece of equipment. The more sophisticated, upscale tourist has got it and they're just going to find it more convenient for getting information from their mobile than an actual PC cause they can pick it up in a nick of time and get back to it so easily.

Similarly another expert commented,

I certainly don't think this sort of technology is going to go away at all.

Global Positioning Systems (GPS) were identified for both tracking and analysis of tourist movements (Shoval and Isaacson 2006) and location identification for tourists. A destination manager can use this information to develop tourism plans for dispersing tourists at different sites and attractions at the destination. This ensures that environmental impacts are better managed in a particular area through 'load balancing'.

Another ICT-based tool/application identified from the primary research as having substantial use for managing sustainable tourism was Geographical Information Systems (GIS). These were used for mapping and profiling tourists to the destination (Lau and McKercher 2007). Using this information, destination managers can monitor the destination and use it to assist with visitor management techniques. A GIS also assists a DMO in transport planning and route identification (Bahaire and Elliott-White 1999; Lew and McKercher 2005). This provides both the tourists and the locals with the safest and quickest routes at the destination. Economic benefits can also be realised from the co-ordination and management of information. GIS was also identified as being used for data integration so as to provide DMOs with a clearer picture of conditions at the destination for better decision-making. For example, experts commented

I think GIS can be used, for example, to monitor different regions of the destination, for example, where there are preserved regions or regions, which are suitable for specific activities. These can of course be planned in a more precise way with a GIS. For example, with better-planned specific activities, the tourists can get equal contact with the nature or the history of the destination or all those things. This can be used quite heavily in the area of destination planning or planning of different activities that can be done in the destination. Therefore, I think GIS are quite important for sustainable tourism development.

We use GIS simply to layer information so that we can establish a clearer understanding between things like market segmentation in a physical sense and partnership working in an industry sense.

Community Informatics (CI), another identified ICT-based tool/application, was used for community engagement, heritage preservation, interpretation and community cohesion (Gretzel et al. 2009), and this tool truly engages with the socio-cultural aspect of sustainable tourism. Through using ICT as the medium, it can connect the community by allowing them greater involvement in decisions relating to tourism development and planning at the destination. This is important since if the locals feel integrated in the tourism process then they will have greater buy-in (Cole, 2006). The strengthening of community identity allows locals to develop stronger bonds with their culture and heritage (Simpson 2008). Innovative ICT usage also assists in the promotion, management and preservation of heritage, customs and traditions that may have been lost (Chaibai et al. 2013). Increasing awareness through CI can support the host community in gaining a better appreciation of their neighbours, their community and their environment. According to Chiabai (2013) eliciting stakeholder participation is a key challenge in terms of social sustainability. This ICT-tool heightens awareness among the host community about sustainability of the destination in an online environment as seen below,

They could exchange ideas about what you should do as a tourist in this area or what you shouldn't do in order to preserve the nature and the culture in this area. So I feel this could raise the awareness of tourists for specific needs in a destination and they can exchange their ideas in an online community.

It can also allow the community to play an important role in what messages are being communicated to the tourists. This gives the tourists a more unbiased impression of the destination and helps them better understand what to expect and how to behave whilst visiting.

It can re-connect that information and make sure that the community has input in how they are being portrayed to the visitor and ensure they become part of their heritage rather than just selling it to the tourists. So in that sense technologies that can be used for the community can have a big impact.

Survey participants saw Carbon Calculators as more of an awareness-raising tool, which allowed tourists to monitor their CO₂ emissions. Interviewees identified this as a marketing and promotion tool for destinations wanting to advertise that they are “green” and environment friendly. However, it was felt that once concerns over climate change intensified, destinations would make greater use of this tool, beyond ‘greenwashing’ to examine both the emissions from destinations and individuals travelling to these destinations as expressed resulting viewpoint.

I know they already exist but I think a lot more effort could go into that. As you assemble the elements of your trip, each element has got its own footprint, carbon footprint. This goes into the itinerary planner and you can see probably your tons of CO₂ and you can change from one hotel which has got one kind of bed numbers, a kind of weighting to a different hotel that's different and you try changing from doing it by air to doing it by train or whatever. And I could see that that could be important. If you get to the stage where travel is rationed, you may actually be obliged to use a carbon calculator because that's the only way that you're allowed to use your ration. So how about that for a bit of future scoping as well. And obviously in short term responsible people, there don't seem to be many, people don't seem to have children, or they've forgotten they've got children and what about their children's children. But responsible people I think will jump at using carbon calculators.

Virtual Tourism (VT) was identified as being a useful contributor to reducing degradation to sites/attractions by reducing tourist numbers (Swarbrooke 1999). Through information distribution tourists can also be educated about the destination. It is debatable whether VT will replace physical travel in the future (Guttentag 2010). This may become a reality with advancements in technology, especially 3D television and in the next decade, holographic television. A number of destinations are already using rich media on their websites to seek to reduce the intangibility aspect of the tourism product. As climate change increases as a significant concern, the future may result in restrictions on air travel in order to protect and preserve the environment. These travel limitations may encourage more people to use VT to experience destinations they can no longer visit. One expert had very optimistic views for VT.

The best way to be green is to stay where you are because the minute you got transportation you're using carbon. I think that I can see a VT. In other words where you're not travelling but you're getting experience. This is going to develop as a product in the future. We might be talking 5-10-20 years ahead. But I can see a time when this will be happening. It won't be called tourism, its recreation, tend to change doesn't it. So what we're really talking about is if somebody wants to be in the jungle or half way up a mountain, you're doing a safari or whatever, there is going to come a time where you will get

amazingly rich, real experiences with your partner or a friend or whatever so that the experiences you share as one. And I could see that emerging as a product but whether you call it tourism or entertainment or leisure, I don't know. I'm sure it will happen. I think it is quite likely that once we get flooding happening and famine and degraded environments and once we run out of enough energy and long haul flights become hugely expensive and people end up having kind of quotas of energy they're allowed to use for unnecessary travel, things like virtual reality could actually become a more significant part of people's recreation.

Computer Simulation (CS) was depicted as being used for predicting trends by simulating scenarios (Lawson 2006) such as climate change and illustrating changes to the environment from tourist usage. This provides the destination manager with realistic images of what proposed tourism developments would look like under varying conditions. This information can be used to make decisions, which have a more favourable long-term impact on the environment and therefore contribute to the destination becoming more sustainable. Other uses of CS are monitoring indicators for sustainable tourism (Lawson 2006) and developing realistic models for use in community consultation exercises about tourism planning and development in their locale (Lawson and Manning 2003).

4.2 Areas of ICT use for Sustainable Tourism

Destination managers' ranked information management as the most important area of applying ICT-ST. Tourism is an information-intensive industry and managing this information is crucial to the success of the industry (Sheldon 1997; Werthner and Klein 1999). Through better information control, destination managers can better plan and manage the tourism industry. Destination managers recognised tourist satisfaction as the second area where ICT tools can be most useful. This may have been identified as being critical since satisfaction is important to tourists returning to destinations and was ranked as being significant. Transport was ranked as third most important because if sustainable solutions can be found for transportation, then destinations can reduce their CO₂ emissions (Lin 2010). Sustainable consumption was fourth followed by enabling partnerships. The least important area identified by DMO was community participation. Outside of this ranking, climate change was identified as another area of concern.

4.3 The Future use of ICT in Sustainable Destination Development

About one quarter (24%) of DMO strongly agreed that ICT has led to the better management of their destination whilst just under half (46%) agreed with this statement. It is interesting to note that about one quarter (24%) was undecided if ICT did lead to the better management of their destination. Just under half (45%) of DMO indicated that ICT will be very important in the future management of ST whilst 41% indicated that it would be important. Eight percent of DMO felt it would be moderately important, 3% felt it would be of little importance whilst similarly, 3% felt it would be unimportant.

DMO were asked to envisage how ICT would be used for their destinations. They visualised that it would be used for increased marketing and better management of the destination through developing networks and partnerships by enabling co-ordination and engaging all stakeholders in sustainable tourism and supporting relationships. It would also be used for improved waste management, energy monitoring, information comparison and integration and fostering better decision-making. It was felt that key information required for decision-making would be easily located and more readily available and this would to increasing productivity and helping to build sustainable business models for destinations. Using ICT-ST will also lead to better communication with the tourist, the host community and tourism businesses at the destination. This will help the diversified stakeholders better understand their responsibility in the ST process and make them more aware of appropriate and ethical behaviours. From the interviews, it was found to be a tool used for personalisation of the visitor experience.

It is the ability to communicate with visitors through their own individual hand held technology to provide them with a map and route system. If we can do that then in terms of the development of sustainable tourism that would perhaps be the most important, because that is a personal Website in a sense. If we can get personal with all of our visitors, we can manage them all more effectively which would provide the businesses with the right level of visitors at the right time at the right place and it would provide visitors with a good quality of experience on the basis that we could produce it in such a way that it became personal to their requirements. We could make sure those people in doing all of those things were avoiding hot spots in terms of physical damage and erosion. We could ensure that these systems are linked with the public transport and appropriate transport connections. It is a tool for making all of the things that are relevant in sustainability work..... it's a very personal tool so it allows all of our visitors to be managed in a personal way which would allow them to have the best

possible time with the best possible economic impact but the smallest amount of environmental impact and social impact.

One DMO conveyed that ICT would help in managing the entire destination in a network of actors and stakeholder whereby various employees would have access to these applications. This is seen from the subsequent statement.

I can see it for destination management in terms of promotion, sales, inventory management and reporting and would involve the co-ordinators or leaders in the region be they a Regional Tourism Authority or at any level or/and operators. It would be an inclusive system that allows them all to participate and work together and build awareness and promotion of the destination as well as for individual products.

It was also seen as a means of measuring impacts, monitoring and reporting. This destination manager envisioned the development of a dashboard, where they can type various requests and queries will be answered as depicted below.

I honestly see it like a dashboard whereby you would input various data and the results would be the internal fluctuations of where things are happening. You could have alerts as well as matching how well you prepare for the external environment and you can look into the ecology and see what's happening there. If you put up a hotel, you know what the impacts are and you could come up with maybe a few focus points at that moment to make certain decisions. This destination dashboard is really the way I see it. That would be a dashboard where you get all this information in one location.

It was seen as being used to complement the current approaches to sustainable tourism.

4.4 ICT, Innovation and Sustainable Tourism

Most DMO (94%) surveyed strongly agreed or agreed that ICT is an innovative approach to sustainable tourism. Only one DMO strongly disagreed while one was undecided. The majority of DMO felt it would be innovative with regards to information management, distribution of this information for critical decision-making, leading to a better understanding of the tourism product, monitoring of the destination, measuring, evaluating and forecasting trends and developing partnerships and engaging and supporting relationships amongst stakeholders. Some of the comments derived from the expert interviews were,

I think very. I think its an area which I explained before has not yet been discovered so I think as soon as people start realising that they can apply ICT in this area that it will be next area.

Accordingly another expert commented:

I think like anything new, it is something that people will need to get use to with regards to the different types of technology that are out there but I believe they will definitely be helpful. It can make the job easier, can make keeping information easier and processing information easier.

Using the Hjalager (1997) typology for ST innovation, the ICT- tools for ST may be classified as depicted in Table 5.

Table 5. Classification of ICT-based Tools/Applications

Innovation Tools	Product innovation	Classical process innovation	Process innovation in information handling	Management innovation	Institutional innovation
Destination Management System		✓	✓	✓	✓
Intelligent Transport System			✓		
Tourism Information System			✓		

Environment Management Information Systems		✓	✓	✓	✓
Location Based Services	✓		✓		✓
Global Positioning System			✓		
Geographical Information Systems			✓		✓
Community Informatics					✓
Carbon Calculator	✓		✓		
Virtual Tourism	✓				
Computer Simulation			✓		

Carbon Calculators, Location Based Services and Virtual Tourism can be classified as product innovation. Carbon calculators will be used to inform the tourists about their carbon composition before and during their trip therefore make informed decisions. Location Based Services can provide tourists with targeted information based on their specific location, whilst virtual tourism will provide tourists with a new option of how to experience the tourism product offerings.

A Destination Management System (DMS) can lead to classical process innovation by reducing the amount of labour required to market and promote the destination. It contributes to the sustainability agenda by being an ICT tools that can aid in tourism planning, tourist satisfaction and interpretation. This process is similar for the use of Environmental Management Information System.

Most of these ICT tools except virtual tourism and community informatics can contribute to process innovation in information handling. Hjalager (2010) commented that ICT has been at the centre of process innovation. These identified tools in Table 3 all play an important role in the way information is collected, analysed, manage and distributed in dealing with a destination's STD concerns.

Management innovations may result from the use of a DMS or an Environmental Management Information System. These tools have the capability to assist DMO in better management of their STD and if implemented will foster the development of new structures and roles in the organisation.

Institutional innovations can be developed through using community informatics, DMS, Geographical Information Systems (GIS), Environmental Management Information Systems (EMIS) and Location Based Services (LBS). Community informatics can transform how the community is consulted in tourism matters, allow the community to play a leading role in how the destination is portrayed, help educate the tourists and preserve heritage and traditions. Even though community participation is deemed to be important for STD, this rarely occurs in practice (Cole 2006). DMS can be used to create new businesses by forming partnerships and alliances with stakeholders at the destination and fostering greater co-operation and communication. By extending its uses for STD, a DMS can offer creative products such as providing a Web space where the community and the tourist can interact, offering an avenue for the community to consult on proposed tourism plans and projects, supply sensitisation information to the tourists for better interpretation of the destination and encouraging more sustainable behaviours and attitudes at the destination. GIS has the power to change the way in which tourism is managed. New linkages are created by involving the community and by forming partnerships to collect data to feed into the system. Through proper analysis of the data, destination managers can make more informed decisions which can create new types of tourism products and services, rejuvenate old sites and attractions and develop parts of the destinations which are suitable for development and protect those which are not. It can also demonstrate to the community that the DMO is serious about tourism development hence having an architectural innovation impact. EMIS can alter the way tourism is managed by monitoring emissions and waste management at the destination. This leads to sounder decision making as well as aids in current approaches such as alternatives to carrying capacity and indicator development and monitoring. LBS can play a pivotal role in not only how sustainable tourism is managed. Destination managers will now have the power to communicate seamlessly with the tourist whilst the tourist will be able to share and exchange information with the local community and other tourists. This builds rich and rewarding experiences which takes into consideration the environment (Racherla et al. 2008).

5 Conclusion

This research sought to progress research in eTourism, sustainable tourism and tourism innovation by establishing that through ICT, destination-based organisations may indeed adopt an innovative approach in managing their ST using Hjalager's (1997) analytical typology. The research approach sought to establish a robust basis for future research work in the area and be of directly actionable benefit for destinations. Such a systematic framework is essential in helping destinations select the best ICT tools for them based on their particular needs relating to ST and stimulating destination innovation. Further exploration is warranted in taking forward this particular avenue of work and ultimately perhaps may provide the basis of e.g. an expert-system to aid decision-making. It should be noted that the researchers can only draw attention to and discuss these ICT tools/applications and examine how they may be used in destination management, however, it is destination managers and DMO that need to take the next steps i.e. implementation. The true ultimate value of the current work will therefore lie in the DMO ability to use the information provided to catalyse transformation in sustainable directions. DMO need to be agents for change (Buhalis and Deimezi 2004) and they need identify the technologies which can support their operational and strategic functions and re-engineer their role in destination management for the benefit of the destination.

This work has focused on those engaged in and with responsibility for destination-wide activities and has emphasised this management-centric perspective. Further work could usefully explore the consumer, the tourist-centric perspective through investigation of pre-, in- and post-trip activities in the context of sustainable tourism. Other research may focus on using technology in supporting sustainable local communities' tourism development. Finally, there is a wide array of other, mainly commercial stakeholders providing the goods and services both at the destination and in transit to and from destinations. This business-centric perspective taken together with the other work would provide for a more comprehensive understanding of the agents at work in sustainable tourism development. The authors hope the current work will provide an early foundation stone for these endeavours.

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