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EJASA:DSS – Electronic Journal of Applied Statistical Analysis

http://siba-ese.unisalento.it/index.php/ejasa_dss/index

e-ISSN: 2037-3627

DOI: 10.1285/i2037-3627v5n1p12

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Published: 29 December 2014

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Electronic Journal of Applied Statistical Analysis
Vol. 05, Issue 01, December 2014, 12-30
DOI: 10.1285/i2037-3627v5n1p12

Big Data and Knowledge-intensive entrepreneurship: trends and opportunities in the tourism sector

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Published: 29 December 2014

The paper focuses on the growing relevance of Big Data as valuable source of knowledge impacting on the creation and execution of knowledge-intensive entrepreneurship. Starting from the comprehension of the emerging attributes of the entrepreneurship, as innovative and knowledge-intensive driver for the competitiveness of the organizations and regions in the scenario of the knowledge economy, the study aims to deepen which are the opportunities offered by Big Data within an entrepreneurial process. Big Data represents an actual field of study, both for the agenda of researchers and practioners, but while a growing set of works are concentrated on the comprehension of the technological dimensions of the phenomenon, its implications in the entrepreneurship is still in infancy. Focusing on this last endeavor, the paper aims to provide an interdisciplinary contribution at the debate on Big Data by demonstrating how the large amount of knowledge distributed in the web can support the conception and execution of an entrepreneurial process more aligned with the customers' needs and focused on the actual market's trends. Based on a qualitative review of an interdisciplinary literature, the paper will define some practical applications of Big Data for the knowledge-intensive entrepreneurship in the field of the tourism.

keywords: Big data, Knowledge-intensive Entrepreneurship, Machine Learning, Predictive Analysis, Tourism.

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ISSN: 2070-5948
http://siba-ese.unisalento.it/index.php/ejasa/index

1 Introduction

Big Data can be considered as one of the most representative and emerging paradigm of the knowledge economy. Due at the large diffusion of the ICTs and their pervasive nature emerging in almost all the dimensions of the daily life, Big Data is the synthesis of the large amount of information, experiences, feedbacks, and thoughts that in a structured or unstructured way people around the world create and share instantaneously. Even if Big Data cannot be defined as a new concept, some elements of novelty can be identified into their entrepreneurial and managerial implications as well as in the technologies to capture, store and manage them (Heerschap et al., 2014). Useful examples of the relevance of the ICTs in the practices and strategies of the knowledge management can be identified in the diffusion of the Web 2.0. Several scholars and researchers have deepen the implications of the social and digital technologies not only for the effects in the social life of individuals, more and more characterized by virtual experiences and interactions (Efimova and Hendrick, 2005), but also for the impact on the traditional marketing, innovation and organizational strategies of the companies (Del Vecchio and Ndou, 2010; Secundo and Grippa, 2010; Tapscott, 2006; Dous et al., 2005, etc). Big Data can be easily assumed as an undefined space of information and a valuable source of inspiration for managers and entrepreneurs. The knowledge-intensive nature of the issue is interesting also under a further interpretation that is due at the contributions that Big Data can provide in making possible the creation and execution of knowledge-intensive entrepreneurial processes. Identified as driver for the competitiveness of individuals, organizations and territories, the knowledge-intensive entrepreneurship is the result of the matching between the technical know-how and the market's needs to afford and win the societal challenges and by this to creating socio-economic value for the larger community of stakeholders (Malerba, 2010). The nature of the knowledge-intensive entrepreneurship shows its relevance in all the industries and sectors. Anyway with this study we aim to investigate its implications in the tourism, also in consideration of the integrated regional nature of the sector, its relevance in terms of knowledge-intensive business services (Vargo and Akaka, 2009; Wood, 2002) and for the socio-economic development of regions and territories. Framed in the above premises, the study will identify some practical implications of Big Data for the execution of knowledge-intensive entrepreneurial processes in tourism.

Based on a qualitative academic and policy-based literature review, the paper is structured as follows: in the first paragraph, the issue of the knowledge-intensive entrepreneurship is afforded with reference to the scientific and institutional debate on its meaning in terms of technological and innovative process and driver for the competitiveness of individuals, organizations and regions in the scenario of the knowledge economy. In the second paragraph, Big Data is described as emerging technological and managerial paradigm with large potentialities and implications in the managerial and entrepreneurial fields. In the third paragraph, the meaning of tourism as integrated sector and knowledge-intensive business service industry is deepen with the aim to capture the strategic contribution it can provide at the socio-economic development of the regions, while in the fourth paragraph, some of the main opportunities offered by Big Data

for launching and sustaining the development of knowledge-intensive entrepreneurship in tourism are presented. Finally, conclusions are devoted to summarize the main evidences and implications resulting from the study as well as to highlight areas for future studies and practical implications.

2 The Knowledge Intensive Entrepreneurship

The knowledge intensive entrepreneurship represents an issue of growing relevance in the current scientific and institutional debate. Defined as the socio-economic process performed by "knowledge operators, able to utilize existing knowledge, integrate different knowledge assets and create new knowledge" (Malerba, 2010), the knowledge-intensive entrepreneurship is, nowadays, largely debated in the works of researchers and scholars, that have recently analyzed its characteristics as innovative or technology-driven process.

The issue of knowledge intensive entrepreneurship can be firstly derived in the work of Schumpeter (1934), where it is defined as the ability to respond to the creative processes of change. In more recent studies, it has been recognized as the process resulting from the virtuous combination of intellectual capital and market's opportunities, and also as the capacity of to manage under uncertainty, to assume the risk of a new venture, to identify and exploit previous unexplored opportunities (Venkataraman, 2004; Byers et al., 2011; Ndou and Del Vecchio, 2012).

As Fig. 1 shows, the knowledge-intensive entrepreneurship arises from matching technical know-how (ICTs and Key Enabling Technologies) and market's needs (Newbert et al., 2007; Gemmell et al., 2011); this process results to be embedded into a complex and knowledgeable network of relationship (Gemmell et al., 2011).

Figure 1: "The knowledge-intensive Entrepreneurship".

The knowledge intensive entrepreneurship is so identifiable into the process emerging from the mixture of individual talents skills, such as creativity, instinct, courage, capabilities of vision, practical sense, passion for innovation and challenges, passion for experimentation and leadership with technical, managerial and financial assets to satisfy customers' needs (Venkataraman, 2004). A further elements charactering the innovativeness and knowledge-intensive dimensions of the entrepreneurship is linked to the ability of interpreting, acquiring and anticipating the needs of the customers. As argued in the work of Webb et al. (2011), there isn't any market opportunity without the market or at least one customer. It is in this perspective that the meaning of the customer knowledge management (Dous et al., 2005; Del Vecchio and Ndou, 2010) results an approach of great relevance for conceiving and implementing a successful entrepreneurial venture.

Equipped also with creativity, innovation and risk-taking as well as ability to turn ideas into action, knowledge-intensive entrepreneurs can been identified as strategic actors for the socio-economic growth. This in reason of their ability of developing a wide array of innovation processes aimed to:

- generate new knowledge through research activities, aimed at the development of a wide large set of innovation;
- adopt and adapt existing technologies and ideas, and by this to increase the propensity for incremental innovation;
- reinforce his-own social capital and innovation networks;
- spread knowledge in the workplace and increase the capacity to absorb new knowledge.

The innovative entrepreneurship has been also described as the result of virtuous integration between research, that creates new knowledge, education, contributing to create competencies and trained and qualified human capital, and innovation, that is the ability to valorize economically and socially the knowledge created (Romano et al., 2013).

nspired by the neo-schumpeterian scientific debate on the innovative entrepreneurship, the topic has recently received the attention of supranational institutions and international agencies; Specifically, in the frame of the European Smart Specialization Strategy, it has been defined as the driver for the achievement of the objectives of the intelligent, sustainable and inclusive growth (Foray et al., 2011; Wintjes and Hollanders, 2010).

According to its nature of place-based strategy, the Smart Specialization identifies different paths of development for the European regions, according to their vocations and starting from the valorization of the key enabling technologies within the entrepreneurial discovery process. Defined as "the enabler for the intelligent and sustainable growth of regions and territories" (EC, 2012; McCann and Ortega-Argilés, 2011 Foray et al., 2011), the entrepreneurial discovery is the process to achieve the objectives of regional intelligent growth, by (McCann and Ortega-Argilés, 2011; Foray et al., 2011):

- switching from existing to new and collaborative industries;

- renovating the existing industries through the adoption of key enabling technologies;
- diversifying the business, through potential synergies positioned in between the existing and the new activities;
- founding new domains and renewing the existing ones through R&D.

Another element of the knowledge-intensive nature of the entrepreneurship can be identified into the scientific debate on the relevance of the entrepreneurial learning. As argued by Cope (2005), Minniti and Bygrave (2001), since the centrality of the knowledge is confirmed by the nature of the competitive dynamics and trends in the current scenario, the process of entrepreneurship shows a growing relevance as process of learning, in all the phases of an entrepreneurial process.

In coherence with the recalled dynamics characterizing the competitiveness of the organizations and regions in scenario of the knowledge economy as well as with the features of the innovative entrepreneurship as a knowledge-intensive and technology-driven process, in the next paragraph the paradigm of Big Data will be presented to understand in which way it can be assumed as basis for the launching of innovative ventures as well as in terms of challenges and opportunities for the knowledge-intensive entrepreneurship.

3 Big Data: the emerging of a new socio-technical paradigm

The term Big Data refers to any set of data that, with traditional systems, would require a large amount of time to be analyzed. As emerging paradigm in the managerial and practical debate on ICT management and business management, its main characteristics have been identified into (Laney, 2001):

- Large size: Terabyte and more;
- Contains both structured and unstructured data;
- Content has a short life-cycle: the value of the analysis of data-set decrease quickly with time.

It's not just the data that's new in the Big Data world, but also many of the technologies for managing and analyzing it (see Fig. 2). What's new about Big Data technologies is primarily that the data can't be handled well with traditional database software or with single servers. Traditional relational databases assume data in neat rows and columns, and Big Data comes in a variety of different formats. Therefore, a new generation of distributed processing tools and intelligent software has emerged to handle it. Big Data users often employ Hadoop, an open-source software toolset based on the MapReduce framework for dividing up data across multiple computers (Davenport and Dyche, 2013; White, 2010). The volume of the Big Data means that it can't be processed quickly on a

Figure 2: Big Data 3v Model.

single computer, no matter how powerful. Fortunately, the rise of Big Data coincides with the rise of inexpensive commodity servers with many, sometimes thousands, of computer processors. A single data processing problem can be divided across these inexpensive servers, and then merged again when it's finished. These new technologies are by no means the only ones that organizations need to investigate for Big Data. In fact, their technology has changed dramatically over the past several years, and it will continue to do so. There are new forms of databases (e.g., so-called "columnar" or "vertical" databases), new programming languages (interactive "scripting" languages like Python, Pig, and Hive are particularly popular for big data), and new hardware architectures for processing data (such as big data "appliances" and "in-memory" analytics) (White, 2010).

There is another key aspect of the Big Data technology environment that differs from traditional information management. In that previous world, the goal for data analysis was to segregate data into a separate pool for analysis, typically a data warehouse (which contains a wide variety of data sets addressing a variety of purposes and topics) or mart (which typically contains a smaller amount of data for a single purpose or business function, such as a customer loyalty data mart). However, the volume and velocity of Big Data, remember, it's a fast-moving river of information that never stops-means that it can rapidly overcome any segregation approach.

Therefore, in the Big Data technology environment, many organizations are using Hadoop and similar technologies to briefly store large quantities of data, and then flushing it out for new batches. The persistence of the data is just enough time to do some

(often rudimentary) analysis on it. This data management approach may not dethrone the "enterprise data warehouse" approach, but it at least seems likely to supplement it.

It's also important in this section to point out what is not so new with Big Data, and that's how it's analyzed. The described technologies are used to either store Big Data, or to transform it from an unstructured or semi-structured format into the typical rows and columns of numbers. When it's in that format, it can be analyzed like any other dataset, albeit larger. If the relevance of the issue and need of managing the large amount of information through statistics is evident for organizations, public and private, several implications for the national and supranational agencies and governments arise also. Coherently, the European Commission (June, 2014) has launched several initiatives on the topic, while some studies have been published in collaboration with Eurostat for deepening specific aspects of Big Data, as for example, the mobile positioning.

The several approaches for converting unstructured data into structured numbers are not entirely new either. For as long as we've been analyzing text, voice, and video data, for example, we've had to convert it into numbers for analysis. The numbers might convey how often a particular pattern or words or pixels appears in the data, or whether the text or voice sounds convey positive or negative sentiment. The only thing that's new about it is the speed and cost with which this conversion can be accomplished. It's important to remember, however, that such a conversion isn't useful until the data is summarized, analyzed, and correlated through analytics.

The tools that organizations use for Big Data analysis aren't that different from what has been used for data analysis in the past, in the travel industry and elsewhere. They include basic statistical processing with either proprietary (SAS, SPSS) or open source (R) statistical programs. The relevance of the statistic in the field of Big Data is confirmed by recent scientific and institutional studies published (EC, 2014; Heerschap et al., 2014). However, instead of the traditional hypothesis-based approach to statistical analysis (in which the analyst or decision-maker comes up with a hypothesis, and then tests it for fit with the data), Big Data analysis is more likely to involve an approach called "machine learning".

This approach, which might be referred to as "automated modeling", fits a variety of different models to data in order to achieve the best possible match. The benefit of machine learning is that it can very quickly generate models to explain and predict relationships in fast-moving data. The downside of machine learning is that it typically leads to results that are somewhat difficult to interpret and explain.

It is well known as the computer program found that certain variables are important in the model, and it may be difficult to understand why. Nevertheless, the pace and volume of data in the Big Data world makes it important to employ machine learning in some situations. Even if Big Data results to be a paradigm industry independent, tourism seems to be one of the industry where its implications are larger and interesting. The mobile position previously recalled in the study if the EC (2014), is just one of the example of this relevance while several implications in terms of competitiveness for the companies operating in are identifiable. As for the online travel agency environment, it is possible to note as where firms use it to rapidly develop predictive models about what targeted hotel search results and rank orderings to show customers.

As described in the box that follows, the case of Kayak.com can provide useful insight for the understanding of the value associated at the usage of Big Data in tourism.

Kayak.com is a travel meta search engine that offers users the possibility to find hotels, flights, vacations and rental cars across hundreds of different booking websites. They handle over a billion searches a year and maintain advertising agreements with over 4.000 travel suppliers and travel agencies including most global hotel and car rental operators, nearly every leading airline globally and the world's leading travel agencies, so it is obvious that they are heavily involved with big data. Kayak introduced predictive analytics for their flights module to predict whether or not the price will go up or down in the next seven days. Kayak developed the predictive search engine by using historical data from search queries from the past years and mathematical models to develop an algorithm that can predict the price. Of course, the forecast remains a prediction and therefore the system provides the visitor with the confidence of the statistical analysis. In order to improve the algorithm, Kayak tracks the flights in the background throughout the (seven) days of the forecast and uses that data to determine if the predictions where actually correct. KAYAK makes use of a variety of Big Data tools and capabilities. Given the amount of data it processes and analyzes, it makes heavy use of Hadoop, and has found it much faster and cheaper than alternative technologies. When Giorgos Zacharia, the company's chief scientist, first joined KAYAK, producing a training data set for the personalization algorithm would take between three and four days; now, with the Hadoop cluster, it takes only a few minutes. The company uses big data scripting languages, and a variety of open-source statistical analysis tools.[a]

[a]source: www.bigdata-startups.com

There is good news and bad news for the travel industry about all of this new (and, in some cases, not so new) technology. The good news is that many Big Data technologies are free (as with open-source software) or inexpensive (as with commodity servers).

The technology is also often available "in the cloud" and can be bought "by the drink" at relatively low cost. The downside is that Big Data technologies are relatively labor-intensive to architect and program. They'll require a lot of attention from technologists in travel organizations, and even some attention from senior managers. It used to be that for most organizations, there was only one way to store data-a relational database on a mainframe. Today and for the foreseeable future, there are many new technologies to choose from, and considerable planning and study will be required to choose among them.

A further evidence on the growing relevance of Big Data in tourism, with implications for companies and institutions, is identifiable into the work published by Heerschap et al. (2014) for the Statistics Netherlands, that summarizes the experience performed in the period 2012-13. By reinforcing the relevance of the statistics for the effective usage of Big Data in tourism, the study focuses on three main examples of innovative application of Big Data statistics, coming from the use of internet for compiling the population of units for touristic accommodations, the use of log data registered through an app for mobile phones and finally the analysis of metadata generated by telecom providers.

The discussion on Big Data highlights the several opportunities and challenges associated to this emerging new paradigm that results composed by two main elements, identifiable into the unlimited knowledge distributed and the several technologies useful for its storage and management (García-Illera et al., 2014). It is this last element to highlight the relevance of the issue for the conception and execution of knowledge intensive entrepreneurial processes that, as recalled in the previous paragraph, are aimed to satisfy the market's demand of goods and services, in a growing number of sectors, by valorizing the knowledge assets. As the discussion pointed, travel and tourism are surely some of the industries on which larger is the impact of Big Data. Due at the nature of the tourism, as industry with the largest impact of the diffusion of ICTs and their digital applications and several inter-sectorial implications, in the paragraph that follows the characteristics of tourism as service-based and regional integrated sector is presented in order to derive useful implications in terms of identification of entrepreneurial opportunities and launching of entrepreneurial processes through Big Data.

4 Tourism at the glance: analysis of trends and opportunities of a service-based and regional integrated sector

Tourism is not a new field of research, however the recent interest of scholars and researchers from different areas demonstrate the existence of several unexplored areas as well as its multidisciplinary nature. This is probably due at the growing relevance of the tourism that is emerging at global level as a phenomenon with several implications and also for its recognized socio-economic relevance. It is in this direction that it is assumed as one of the largest industry in the world.

As argued by Page and Connell (2009), tourism is one of the most representative dimension of the globalization and a lot of contributions by authors in a wide large spectrum of disciplinary fields have attempted to analyze its geographical, ecological, agricultural, urban, managerial, sociological and technological dimensions. Always in the study of Page and Connell, several areas of critical analysis and future deepening are identified as that one related to the data sources of tourism. Framed in this premise, through this study we aim to provide a contribution at the discussion on the perspectives of entrepreneurial development in tourism by focusing on Big Data.

Due to the large and differentiated set of products and services involved into a touristic experience as well as to the nature of the phenomenon, the analysis of tourism requires

the adoption of a systemic approach. It is in this perspective that we refer to the tourism as a regional integrated sector arising from the convergence of a plurality of industries (as in Fig. 3). At this purpose, we note as while there is a consolidated literature regarding the disciplinary implications of the phenomenon, the analysis of its inter-sectorial nature is still in infancy and suggests opportunities for further speculations. A further evidence

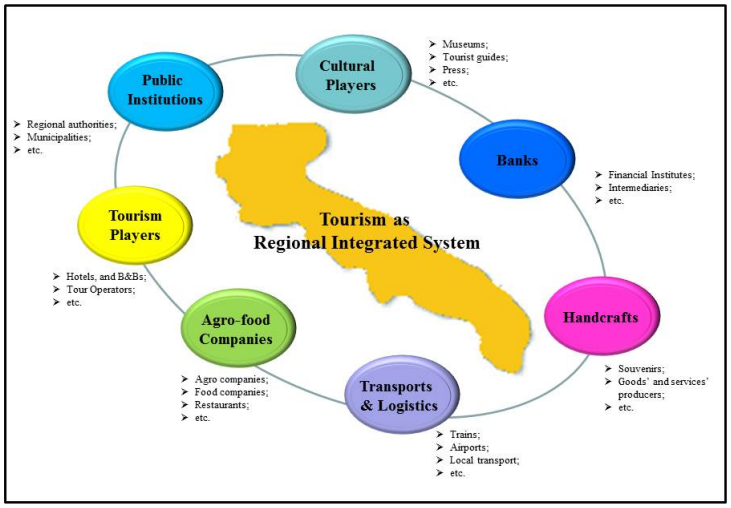

Figure 3: "Tourism as regional integrated sector".

on the meaning of tourism as regional integrated system is highlighted in the definition of tourism of WTO, that in 1991, identified into the economic return for the regional actors one of the element for the definition of the phenomenon.

The contribution of scholars and researchers from different fields highlights the importance of the tourism as global phenomenon but also provide a fragmented and rich overview of the topic.

In the current scenario, characterized by the large diffusion of the ICTs and by the knowledge as primary asset of the competition of individuals, organizations and regions, tourism arises more and more as a knowledge intensive service industry. This is because tourism, as personal experience resulting from the visit in a certain area, results to be composed by a set of services and products with a growing relevance of knowledge. This is due at the pervasiveness of the ICTs, and more recently to their availability on mobile mode. As argued by Buhalis and Law (2008), the issue of the adoption of ICTs in tourism is a well consolidated field of study, however their implications in terms of enabling factors for the emerging nature of tourism as service-based and knowledge intensive industry are still unexplored.

Through the web, users can not only book almost all the services for their future journeys, sometime also with interesting economic advantages, but they can also realize a

virtual pre-tour of the destination identified. The web enables, nowadays, the possibility to mature responsible decisions by learning from the official sources and also from the users' feedbacks available online. This has significantly reduced the risks associated to the booking in an unexplored destination by benefiting of the different and democratized knowledge experiences available online. In providing an interesting synthesis of some of the main implications of the ICTs on tourism, the processes recalled well describe the meaning of tourism as knowledge intensive industry.

Focusing on the economic contribution of ICTs to the tourism industry, according to a recent study of the BTO (Franchini and Del Forno, 2012), almost the 7% of the traffic toward the touristic websites is generated by the social travel platforms. Trivago.com, Tripadvisor.com, Tripwolf.com, but also Instagram, Facebook.com and Twitter.com are only some of the most recognized social platforms for travelers. On the virtual pages of these web sites, tourists have not only the possibility to know and compare their intentions of trips and journeys, but also to share and learn from the others, to acquire suggestions and recommendations for maximizing their time in the destinations, to explore them before to be there and continue to be linked to them also after the vacation.

It is in this venue that in a recent study of 2013, Neuhofer et al. focused on the "technology enhanced tourism experiences" as integrative conceptual framework to describe tourism of our days as combination of "experiences, co-creation and technology" (Neuhofer et al., 2013).

Based on the above premises and on the contributions of scholars and research in the field, the study aims to focus on the offer of knowledge intensive services for tourist and by this to understand which are the opportunities coming from the large and fragmented portion of knowledge about the tourist destination to support the competitiveness of organizations and individuals operating in the tourism. It is in perspective that the touristic offer of a destination can be assumed as composed by knowledge intensive business service (KIBS). Introduced by O'Farrell and Moffat (1991), KIBS are identifiable into that services offering to the customers strategic info and deepen knowledge. KIBS are surely the result of the knowledge-intensive configuration of the current social and economic scenario (Antonelli, 2000), in which the competition of individuals, organizations and also territories is more and more depending from their capacity of acquiring, managing and maintain their both internal and external knowledge assets (Miles, 2003; Toivonen et al., 2008; Del Vecchio and Ndou, 2010).

Another interesting perspective of analysis of the tourism as socio-economic phenomenon is offered by the study of Page and Connell (2009), who defined it as a "service sector". This is extremely coherent with the scientific discussion on the service science (Aarikka-Steroos and Jaakkala, 2012; Spohrer and Maglio, 2008), and the process of growing tertiarization of the economy (Kuusisto and Meyer, 2003).

Another element of discussion on tourism is represented by the global dimension of the phenomenon previously recalled and that means that the competition at which now the destinations are called to afford present a global scale of action. The large diffusion of the ICTs and the several digital applications have opened a wide large spectrum of opportunities at global level, but they are also representative of threats and new

competitive dynamics emerging in all the world. The large development of the online search tools, the empowered capacity and speedy of the network and mainly the recent development of the digital applications have impacted on the traditional ways by which tourists operate to plan and execute their trips (Buhalis and Law, 2008). This highlights the growing importance of the digital tourism as well as the areas of opportunities and threats emerging for the business actors operating in the sector. The competition between companies and destinations is now opened towards global players and space, while the virtual dimension of the tourism experience is growing more and more.

Focusing on the centrality of the knowledge-intensive entrepreneurship in the regional dynamics of development and its declination in tourism, in a study of 2009, Ateljevic argues as there is a linkages between the small tourism firms and the new product development as well as the innovative entrepreneurship. In the meantime, the author highlights as the small dimension of the firms, in the tourism as well as in other sectors, represents a barrier at the entrepreneurial development, in reason of the weak managerial readiness (Stokes, 2000), limited specialization in specific core disciplines (Irvine and Anderson, 2004), scarcity of financial resources (Jarvis, 2006), regulatory external environment not able to support the entrepreneurial development of the destination (Smallbone and Wyer, 2006).

A further element highlighted by the study of Ateljevic (2009) is represented by the nature of the ownership of the large number of small firms operating in tourism. They result mainly owned by familiar clans (Morrison, 2006), and this is sometime identified as the main limit at the development of the sector. Anyway, in the study, the author demonstrates the contribution that tourism can offer at the regional development, and specifically for the emerging ones. In analyzing what happened in New Zealand, Ateljevic (2009) identifies into the foreign investments the driver for the local development of the destination, even if it results limited to the major cities and a limited number of large projects.

Coherently with the current debate on the innovative entrepreneurship, and mainly with its attribute of sustainability, the analysis of tourism and its potential entrepreneurial development offers the opportunity for an additional consideration: to operate as an innovative entrepreneur in the tourism has to mean also to provide the right attention at the social and environmental dimension of the socio-economic processes performed. This also because, a large part of the opportunities for the development of a tourism destination is due at the richness of the area in terms of natural and cultural heritage resource. An innovative tourism entrepreneur surely has to demonstrate awareness about this dimension and to act and instill into the others the respect for the natural ecosystem.

5 Big Data and Tourism: opportunities for creating knowledge intensive entrepreneurship

The discussion on the knowledge-intensive entrepreneurship, on Big Data as paradigm with several technological and managerial implications as well as on the tourism as integrated regional sector largely interested by the pervasive adoption of the ICTs and the

emergence of knowledge-intensive services highlights the wide large set of opportunities arising in terms of regional entrepreneurial development.

Specifically, it is possible to note as the term Big Data is being used more and more frequently in the tourism industry, and appears to be something that tourism organizations need to take a closer look at. Those are the reasons of the interesting addressing the whole study, and mainly the speculations in terms of emerging opportunities for the knowledge-intensive entrepreneurship.

The relevance of Big Data in tourism is specifically due at the nature and dynamics characterizing the sector. Travelers leave different digital traces behind on the web and when using mobile technologies. Through every traveler, big amounts of data are available about anything that is relevant within the holiday stages: prior, during and after. Most of this data is of an external nature, for example, in the form of Twitter or other social networking feeds. Due to the large amounts of data available being stored in the cloud, analytics are needed in order to make sense of the information within the data.

Through the use of Big Data, tourism offer of services and products can become more efficient, and there are more and more entrepreneurial opportunities arising into the services necessary to benefit of Big Data, such as the storing and evaluating the big amounts of data on travelers' hotels, mobile positioning, RFID, public transport, bank's transactions and customers' information to facilitate this.

Big Data is so important because it can deliver much needed business insights, and can be the source of innovation for tourism organizations and the industry in general. By impacting on the different stages of an entrepreneurial process, the potentiality of Big Data in tourism is huge and existent and potential entrepreneurs in tourism should not underestimate its importance.

With the right approach, the tourism industry can learn a lot about consumers' preferences and use this information and insight to build connections with individual tourists. Being able to offer them the right service or product at the right time is crucial. And to develop them in collaboration with the customers, and benefiting of their knowledge and suggestions is strategic. Without the right information and a very good targeting approach, advertising will not result in any conversions and there will be no economic and financial results. Tourism is such a fast-paced industry, which really drives the need for speedy data analytics, statistics and quick decisions. In tourism, any demand needs to be addressed instantly in order to still be relevant for travelers, which makes Big Data so important.

Framed in the above premises, in this paragraph we aim to describe some of the main payoffs and opportunities in terms of knowledge-intensive processes and services for supporting the creation and execution of innovative entrepreneurial ventures in tourism through the usage of Big Data. The description that follows is also supported by the identification of technological solutions available as well as by the reference at cases that have just experimented them. The main are identifiable into:

- **Better decision support:** Many companies operating in tourism, and mainly the travel firms are using Big Data not just to speed up decisions and data pro-

cessing, but to make better internal or customer-focused decisions. In some cases these also benefit from the increased speed of Big Data processing offered by new technologies. In many cases the relevant data is internal. These systems contain a variety of customer data, for example, which can be used to improve marketing and service processes. External Big Data also offers the possibility of improving other types of travel industry decisions, with benefits involving efficiency and safety. Forecasting consumer demand, for example, could be improved through the analysis of macroeconomic and weather data.

- **New products and services for customers:** one of the most exciting possible benefits from Big Data is the creation of new products and services for customers. Outside the tourism industry, this benefit has been pursued aggressively by firms such as Google, LinkedIn, and Facebook. Within the travel sector, the most likely creators of data-based products and services are online travel agencies, travel search firms, and leading technology providers. Amadeus, for example, has developed the "featured results" and "extreme search" capabilities for its customers to improve the travel search experience. The travel search website Hipmunk has developed new features like the "Agony Index" for rating airline flights, and the "Ecstasy Index" for hotel searches. The travel meta-search site Kayak has developed a predicted price offering.

- **Better customer relationships:** since customer relationships have historically been fragmented across a variety of systems and databases, data aggregation should create better customer relationships, and more revenue from customers from better-targeted products and services. Through predictive analytics, the most-favored destinations, lodging and dining preferences, ancillary service needs, and tourism experiences can be identified for each passenger. Online analytical services such as price prediction and desirability rankings can increase the likelihood of purchase. The most advanced approaches to customer targeting involve various forms of online travel advertising. Online travel agencies, aggregators, and review sites all practice ad targeting based on customer behavior. Most travel providers employ some type of intermediary, such as Criteo or Facebook, to place their online ads. Criteo has found that when a relevant, personalized ad is displayed, there is an eight times greater click-through on banners than for an untargeted ad, and customers are eight times more likely to engage with an ad to buy a ticket or package. Criteo has a collaborative filtering algorithm that lets the company predict the most attractive travel package, air route, or hotel.

- **Cheaper, faster data processing:** new generations of information technology have always been dopted in part because they offer better price/performance ratios. Given the enormous amounts of data that travel companies have to churn through, and the relatively thin profit margins in the industry, the appeal of cheaper, faster big data technologies is obvious. Clusters of commodity servers running Hadoop and other open-source software can process data at costs fifteen to twenty times lower than previous generations of data warehousing technology. However, for

the travel industry this on-paper benefit is not easy to adopt, at least outside of online businesses. Airlines and hotel chains, for example, depend heavily on big data for operations, and the Hadoop-based architectures are not as reliable and secure as previous technology generations. Secondly, integrating Hadoop-based architectures with the existing "legacy" technology architectures will be challenging. Nonetheless, some mainstream travel companies, such as Air France-KLM, have begun to experiment with it and plan to use it for production applications.

- **Niche rather generic recommendation:** Big Data technologies and the rise of mobile device adoption let customers call for an extensive reduction of the information overload and more customized travel recommendations. The emerging mobile Recommender Systems are tailored to mobile device users and promise to substantially enrich tourist experiences, recommending rich multimedia content, context-aware services, views/ratings of peer users, etc. New developments in mobile computing, wireless networking, web technologies and social networking leverage massive information that can be managed by Big Data techniques to provide highly accurate and effective tourist recommendations that respect personal preferences and capture usage, personal, social and environmental contextual parameters.

The pay-offs discussed are representative of processes of improvement for existing companies operating in tourism, but they could be assumed as a valuable source of opportunities for creating new entrepreneurial ventures. The nature of the Big Data paradigm is the main assumption behind the new configuration of the knowledge-intensive entrepreneurship in tourism that as described in the previous sections of this work is more and more configurable as the experience resulting from the matching between the local offer of a regional integrated system and the demand of services and products arising at global level. The growing relevance of the knowledge dimension behind such demand and offer and its implications in terms of regional knowledge-intensive entrepreneurship highlights the importance that Big Data can assume in the scientific and institutional agenda for the intelligent growth of regions with touristic vocation.

The conceptualization of the process of knowledge-intensive entrepreneurship in tourism is synthetized in Fig. 4 that follows:

Conclusions

Framed in the scientific and institutional debate on the intelligent growth of the regions, the paper aimed to deepen the opportunities offered by Big Data at the conception and execution of a knowledge-intensive entrepreneurial process. The relevance of tourism as regional integrated system and industry with large implications for the development of a destination arose in the study as field of primary importance for analyzing the opportunities offered by the emerging paradigm of Big Data in development of knowledge-intensive entrepreneurship. The centrality of such knowledge-intensive entrepreneurial process discussed in the paper is due at the contribution it can offer for the regional

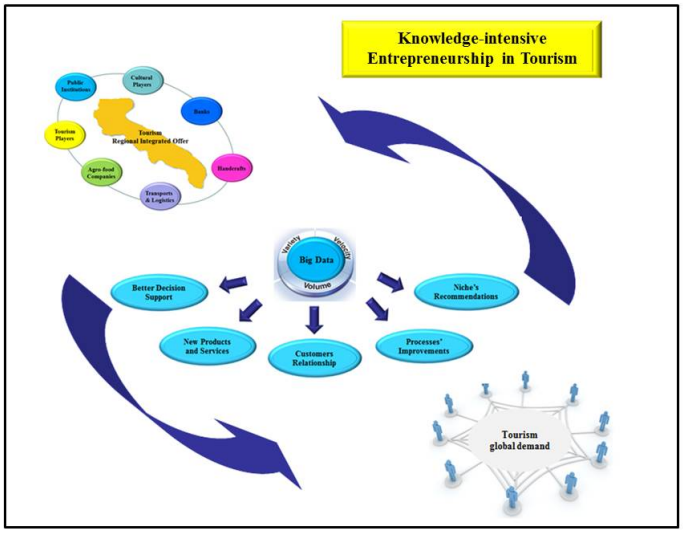

Figure 4: "Big Data for Knowledge-intensive Entrepreneurship in Tourism".

socio-economic growth and higher level of employment. Based on a qualitative academic and policy-based literature review, the study has highlighted the main features of the knowledge-intensive entrepreneurship as well as some of the entrepreneurial opportunities emerging in tourism by the adoption of Big Data. The main payoffs identified are related to a more efficient decision support system, a larger opportunity for innovation in products and services, a more efficient management of the relationship with customers, with a larger involvement of them in the major customization of customers' experience, a general improvement of all the processes of the entrepreneurial venture, a more effective strategy of differentiation. The description of those pay-offs has been enriched by technological and organizational solutions able to support their implementation and also through cases and best practices. As for the future investigations and practical implication, the study allows to identify several areas of interventions. Specifically, it could be useful to enlarge the basis of practical evidences on the adoption of Big Data by companies operating in tourism, also by testing the adoption of tools, but also to contextualize the perspective of tourism as integrated sector to different regional destinations. About the implications, the recalled experiences of the Statistics Netherlands as well as the ongoing project launched at European level on the innovative usage of Big Data in tourism allow to identify a set of practical issues for organizations public and private that are called to afford the challenges due at the privacy issues, associated to the large amount of knowledge distributed and collected as well as for the technological infrastructures and human capital competencies necessary to address effectively such knowledge towards an innovative offer of tourism services.

Acknowledgement

This paper provides a contribution to the research related to an on-going project (*Puglia Service* - Internet-based Service Engineering enabling Smart Territory structural development) leaded by the Apulia regional technological district D.HI.TECH and funded by the Italian Ministry of Education and Research (MIUR).

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