Big Data Analytics
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Big Data Analytics (BDA) can be defined as an integrated process through which data is collected, stored, pre-processed, processed, analysed, reported and visualized by means of Big Data technologies to discover complex patterns of relationships within data and generate insights relevant for strategic, tactical and operational decision making. These insights are used by decision makers for multiple objectives including business process optimization, performance and profitability enhancement, better customer satisfaction and journey, improved agility, establishment of a competitive advantage and ultimately value creation (Fosso Wamba et al., 2017).

Big Data Analytics are increasingly important for several reasons. First, BDA help managers and decision makers uncover complex patterns of relationships within large volumes of apparently unrelated data. Therefore, they support data informed decision making. Second, BDA are one of the nine technological pillars of the fourth industrial revolution (Rüßmann et al., 2015). Therefore, they represent an enabling technology of digital transformation of business. Third, BDA assist firms to enhance their performance and competitive advantage (Davenport, 2006).

BDA are becoming increasingly relevant for multiple firms in the tourism, travel, and hospitality sectors. For instance, the international hotel chain Marriott is constantly investing in BDA to guide its strategic and operational decisions through an ad hoc Data Strategy and Governance team. The company's Data Strategy and Governance team leverages large amounts of high-quality structured, semi-structured and unstructured data in the guise of customer feedback (expressed both off- and online), adoption and usage of loyalty programs, transactional activities, socio-demographic data, local events schedules, and weather reports. These data are used to generate BDA that are used to predict demand, enhance customer satisfaction, attract new customers, optimize pricing, maximize revenues, identify revenue streams beyond rooms, open new markets, identify new business opportunities, and benchmark competing hotels.

The Schiphol airport in Amsterdam retrieves big data (BD) from camera images, 70,000 sensors, flight movements, and information systems. BD is used by the Data & Analytics expertise centre of the airport to derive data driven insights that can help the airport management improve their strategic and operational decisions. In addition, the airport shares its data and BDA with such partners as airlines, handling companies, tour operators and transportation companies moving their customers to/from the airport. How do Schiphol airport's BDA support airlines, handling companies, tour operators and transportation companies moving their customers to/from the airport? First, Schiphol airport offers application programming interfaces (APIs) through the Schiphol developer centre to the airlines operating in the airport to improve airlines companies' operational excellence and passenger satisfaction. Second, airlines can use the airport's APIs - the Boarding Pass API, the operational Flight API, the Wayfinding API - to use the airports' data in their customers' and employees' apps as well as their operational applications. This allows both customers and employees to use uniquely their smartphones to keep up to date in real time about last-minute changes of gates, seats on the plane, fastest ways to get to a certain area of the airport. All of this is based on their actual location detected through the GPS sensor of their smartphones. Overall, this improves airline customers' and employees' experience and optimize their time.

Third, handlers can use the Boarding Pass API, the operational Flight API, the Beacon Registry API and the Wayfinding API to improve their operational efficiency by accessing directly airport's data. This way they triangulate in real time data of the boarding passes, flights, geolocation of the bags to derive BDA to minimize mistakes in dealing with baggage/luggage especially when flights are delayed and/or other unforeseen circumstances modify the flying schedules. Fourth, tour operators and transportation companies can use the airport's Wayfinding API, Operational Flight API, and Wait Times API to use airport data to improve their own travellers' apps and systems. For instance, the Wait Times API allows transportation companies waiting for travellers flying into Amsterdam to get real time updates and estimates of the time necessary for the passenger to reach the meet and greet area after she has landed or update the meeting point between the driver and the passenger in real time without any need to make a telephone call.

Extant research on analytics and BDA in tourism and hospitality has deployed analytics mostly in relation to UGC data as well as location data to derive insights about customer's behaviours and preferences, as well as visitation patterns in relation to tourism destinations, products and services ; (Mariani, 2019). However, several scholars have suggested that so far not many studies have managed to develop solid theoretical frameworks to make sense of BDA (Mariani et al., 2018). Indeed, tourism scholars have largely ignored theorizations of BDA and especially BDA capabilities (BDAC) that have been developed in the information management field to describe BDAC as an organizational ability to collect, combine and use its BD specific resources (Gupta and George, 2016).

Based on the Resource-Based Theory of the firm, BDAC relies on three main types of resources: tangible resources (such as data and technology), intangible resources (such as data-driven culture), and human resources (such as technical data-specific skills). Not all tourism firms have sufficient tangible, intangible and human resources to develop in-house BDAC. For this reason, it is frequent that, especially smaller tourism firms (that are the majority of tourism firm), might decide to outsource the production of analytics to third parties. Overall BDAC are critical to generate accurate and meaningful BDA that will then allow tourism firms to achieve several major benefits for decision making and value creation including: demand forecast, customer satisfaction enhancement, new customers' attraction, pricing optimization, revenues maximization, new business opportunities identification, and competitors benchmarking.

The overall process underlying BDA generation for tourism firms' value creation and business improvement is illustrated in Figure 1 where Big Data in the form of UGC data, device data, sensors data and transaction data retrieved by a tourism company (a hotel chain, an airport, an airline company, etc.) is later processed, stored, analysed, reported and visualized by leveraging BDA capabilities that can be present in house (for large firms with proprietary big data systems like Schipol airport) or are outsourced to BDA companies. This allows to produce analytics that are used to generate relevant insights leading to value creation for the focal firms and its stakeholders. For instance in the case of Schipol airport, BDA are not only used by the airport to improve its operations and create value for its customers, but it also allows other firms – airline companies, handling companies, tour operators, etc. - to use the airports' BDA through APIs to improve their own services and create value for their customers.

[Insert Figure 1 about here]

While there are important and tangible benefits stemming from BDA, tourism firms have to face important challenges. More specifically, they need to continuously strike a balance between: 1) the accuracy of data retrieved (be them UGC, device, sensors, or transaction data);

2) the cost to build and operate technologies relevant to generate BDA; 3) the time needed to generate BDA; 4) the technical skills required to develop BDA; 5) the skills needed for the tourism firms to make sense and interpret the BDA (which is a function of the complexity of the algorithms used). Tourism and hospitality practitioners are well aware of these challenges: for instance, while speaking at the 2017 HSMAI's Revenue Optimization Conference, the former senior director of operations research at the world renowned hotel chain Marriott International Nancy Pyron stated that while the complexity of an analytical model can vary significantly – from simple means, to moving averages to neural networks – the degree of complexity also interrelates with the accurateness of the data, and the cost and time needed to build and operate the analytical model itself.

In the future BDA will become increasingly more important and tourism firms will compete fiercely on analytics (Davenport, 2006). This has three main implications. First, both analysts and practitioners should increasingly examine the antecedents and determinants of successful generation of meaningful BDA. Second and related to the previous point, to generate meaningful BDA, tourism firms will need to equip themselves with appropriate BDAC, which might mean that they should invest to produce BDA in-house or alternatively outsource them to an emerging ecosystem of BDA companies (Mariani & Fosso Wamba, 2020). Third, tourism firms will need to shift their focus from marketing to innovation analytics (Kakatkar et al., 2020) to continuously support their innovation initiatives that are critical for tourism firms to keep a competitive edge and innovate and pivot their value propositions to cater to rapidly changing markets.

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Figure 1 – BDA generation for tourism firms' value creation and business improvement