

BIG DATA FOR BETTER TOURISM POLICY, MANAGEMENT, AND SUSTAINABLE RECOVERY FROM COVID-19

DECEMBER 2021

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Co-publication of the Asian Development Bank and the World Tourism Organization.



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On the cover: Beach in Chuuk State, in the Federated States of Micronesia. Many small island developing economies depend heavily on tourism. Photo by ADB.

Cover design by Mike Cortes.

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ABBREVIATIONS

ADB	-	Asian Development Bank
APEC	-	Asia-Pacific Economic Cooperation
COVID-19	-	coronavirus disease
GDP	-	gross domestic product
ICAO	-	International Civil Aviation Organization
ICT	-	information and communication technology
OECD	-	Organisation for Economic Co-operation and Development
PRC	-	People's Republic of China
RESAS	-	Regional Economy and Society Analyzing System
SMEs	-	small and medium-sized enterprises
STB	-	Singapore Tourism Board
UNSD	-	United Nations Statistics Division
UNWTO	-	World Tourism Organization

FOREWORD

Tourism suffered the greatest crisis on record in 2020. International arrivals plunged by 73% as the COVID-19 pandemic prompted nearly all governments around the world to introduce a range of measures to restrict travel, including border closures to tourists.

One billion fewer international tourist arrivals for the year translates into an estimated loss of nearly \$1.1 trillion in worldwide exports and over \$2 trillion in direct tourism gross domestic product (GDP), more than 2% of the world's GDP. The pandemic has also put more than 100 million direct tourism jobs at risk, with women, youth, and micro, small, and medium-sized enterprises being the most vulnerable.

All world regions were affected, though the impact has been somewhat more pronounced in Asia and the Pacific. As the first region to experience the pandemic, it has recorded the largest decrease in arrivals, with 300 million fewer tourists welcomed last year when compared with 2019, a fall of 83%. This has placed a large number of livelihoods and businesses at risk, especially in destinations where tourism is a pillar of economic growth, such as small island developing states.

The COVID-19 pandemic has accelerated the shift toward digitalization and has highlighted the need for relevant and reliable data and intelligence to manage tourism. Only with these tools can we support recovery, guide decision-making, and inform future planning. Both governments and the private sector are looking to complement official statistics with big data so as to better understand changes in consumer behavior and to enhance recovery with targeted products, segments, and source markets. Big data is also key to supporting seamless travel through the implementation of safety protocols, biosecurity technologies, and digital health certificates to enable the safe reopening of borders.

However, there is still much to be done before we fully realize the potential of big data and digitalization for better tourism policy. Concerns over privacy, skills gaps, data reliability, inadequate governance and infrastructure, the digital divide, accessibility barriers, or lack of financial resources are restrictive factors standing in the way of wide, safe, and fair access to big data. These challenges point to a comprehensive agenda to pave the way for the effective use of big data to assist tourism recovery and its transformation toward a greener, more resilient sector. Policies should be aimed at establishing measurement, monitoring, and management systems and frameworks, thereby ensuring harmonized, comparable, and reliable data and indicators.

There is also a need to enable multilateral financial and investment mechanisms, especially for tourism-dependent countries and for small and medium-sized enterprises with capacity constraints. Likewise, it is important to create incentives and regulations to facilitate data sharing through public–private partnerships, enabling wider access. This report shares good examples from several locations in Asia and the Pacific, showing how they are already leading the way in using big data for marketing strategies or complementing official tourism statistics. It also showcases the main trends in the use of big data in tourism in the region at the forefront of technology and innovation, as well as the role that big data can play in supporting the measurement of the economic, social, and environmental dimensions of tourism.

As global tourism looks to restart and recover, we trust data and market intelligence will empower destinations, businesses, and tourism workers to get better prepared in a rapidly changing landscape. Cooperation is more important than ever in rebuilding smartly. We strongly welcome the collaboration between the Asian Development Bank and the World Tourism Organization. The active involvement of partner governments and regional and international bodies will help to put data, innovation, and sustainability at the center of the safe restart of tourism.



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EXECUTIVE SUMMARY

The coronavirus disease (COVID-19) pandemic has hit tourism hard, nowhere more than in Asia and the Pacific. The region in 2019 had welcomed the world's second-highest number of international tourists and was slated to account for 30% of the global tourism market by 2030. By the end of 2020, international tourist arrivals were down 84%, and over 50% of the destinations remained fully closed to international travel (UNWTO 2021a). Many developing economies in Asia and the Pacific depend heavily on tourism for employment and income, so the sector's recovery is critical for their economic growth to resume. At the same time, the pandemic allows a rethink of the structure of the tourism sector to increase its alignment with environmental and other public policy requirements. As tourism destinations gradually reopen and policies aim to spur a sustainable recovery, the opportunity to rebuild smartly should not be overlooked. This view is in line with the Asian Development Bank's (ADB) Strategy 2030, which envisions a prosperous, inclusive, resilient, and sustainable tourism sector in Asia and the Pacific, and with the priorities of the World Tourism Organization (UNWTO) guided by the 2030 Agenda for Sustainable Development.

Big data consists of the large, diverse, structured, and unstructured datasets of information generated and transmitted at ever-increasing rates by organizations, people, and machines. It is characterized also by the speed it is created, stored, and visualized. If properly processed and analyzed, big data can provide valuable insights into trends, behaviors, and prospects, and show the way for appropriate policy actions. As such, it can be an important tool to inform policy formulation and implementation for tourism recovery and development. Big data is beginning to be used widely to measure, monitor, and manage tourism developments. However, the potential of big data and digitalization remains to be fully exploited, while its challenges and pitfalls must be attended to for effective policy.

This report discusses opportunities and challenges for using big data in tourism. It reviews trends in the use of big data and highlights how big data is being leveraged for COVID-19 recovery, and its relationship with statistical frameworks to help measure tourism's economic, social, and environmental impact on destinations. It then outlines the major challenges to adopting big data for tourism purposes. Analysis includes evidence from numerous case studies on how the public and private sector in Asia and Pacific destinations are partnering to fully tap big data. The report can help countries in the region and national tourist organizations

compare, evaluate, and improve policies and programs for working with big data in tourism. It can also inform ADB, UNWTO, and other organizations on the best ways to support tourism in the region.

Background

The tourism sector has long generated an enormous volume of big data through vast interconnected business-to-business booking platforms. With the emergence of digital travel platforms in the 1990s, big data for tourism began to take on its important business-to-consumer dimension. Today, enormous datasets are being compiled that include data collected by tourism digital platforms such as online travel agencies and global reservation systems when consumers engage in online travel searches and bookings and by an array of other industries. Other technology giants such as Google and Facebook also collect substantial data on consumer travel habits and businesses, but travel and tourism operatives can only access limited data and information through the so-called gatekeeper platforms of these companies.

Opportunities of big data

In partnership with online travel agents, telecommunications companies, and financial services companies, governments around the world are tapping big data to formulate and implement tourism-related policies. In particular, as explained in this report's case studies, Japan, Singapore, and Thailand have been using tourism big data obtained through such partnerships to inform policies to attract consumers from particular markets, targeting advertisements, and generally improving marketing strategies. In Australia, Indonesia, and New Zealand, too, big data is being used to generate or complement official tourism statistics.

COVID-19 has accelerated digitalization and the use of big data as national and regional governments seek to better understand the pandemic's impact on traveler movement and habits and support safe and sustainable recovery by helping businesses to develop better and smarter products and services. Digitalization has also fostered introduction of seamless travel technologies and accelerated the piloting of digital travel certificates powered by blockchain technology to enable the reopening of borders. The widespread adoption of this technology is often hampered by concerns about data privacy. But blockchain technology could ultimately help overcome the extensive challenges involved in sharing health data across borders.

Key challenges posed by big data

Despite the emerging partnerships and big data programs, significant challenges remain in big data implementation and management by governments in the region, some of them outlined below. Working with big data requires advanced technology and specialized skills, as well as strong legal and institutional frameworks, which are lacking in many developing economies. While global demand for skilled information

and communication technology (ICT) employees continues to grow, there is already a pronounced deficit in these skills in the Asia and Pacific region, making it hard for the public and private sectors to attract and retain the talent required to work with big data. The region also suffers from a digital divide in its ability to deal with big data for tourism. This shortcoming can be addressed to some extent by working with big data providers through partnerships that allow access to big data and reports, but the skills gap cannot be resolved in the short run and requires major investment in education and training that many destinations in the region can ill afford.

Working with big data raises complex legal and technical privacy and cyber issues as well. Safeguarding sensitive and personal information and determining the extent of dissemination of the data compiled requires skills and technical infrastructure that many destinations lack and can only be obtained at high cost. Cybercrimes and data breaches pose an increasing security threat to individuals and destinations, especially those lacking ICT skills. Although full security is unlikely to be possible given the rapid pace of technological change, continuous and proactive vigilance by skilled personnel to detect and prevent cyberattacks are the best line of defense.

The availability of big data valuable for tourism for public use is circumscribed for a number of reasons. First, data sharing across jurisdictions is sometimes subject to localization laws that confine data storage or processing exclusively to a specified jurisdiction. Second, only a few private firms collect and store most of the data, and private corporations do not normally share such data without financial incentives. Thus, countries lacking financial resources find access to such data especially circumscribed. Even as these developing Asian countries invest in big data programs to reduce structural dependency, the insights they gain are unlikely to benefit the small and medium-sized enterprises (SMEs) that cannot use advanced digital tools, although they do no doubt benefit large firms.

Pitfalls of big data

Pitfalls in the use of big data do detract from its value for tourism development. Big data often overlooks people from the most vulnerable populations, or the so-called “data invisibles,” given their lack of a digital footprint due to the present and expanding digital divide. Indeed, big data contains selection biases that are largely absent from official statistics. Also, while official statistics are reliable and trusted because of the rigor and the continuity of the underlying conceptual framework for their compilation, this continuity does not uniformly apply to big data. Thus, reliance on big data must be tempered by the need to filter out such biases and the data used primarily to complement official statistics.

Policies for the effective use of big data in tourism

The challenges and pitfalls of big data call for a comprehensive policy agenda that encourages its effective use to help tourism recover from the pandemic and transition into a safer and more sustainable sector. Developing such an agenda requires tourism's representation on a multi-ministerial task force. This could facilitate a government-wide approach to allocating resources for the compilation and analysis of the data and for capacity development in government, official tourism organizations, and destination management organizations.

In both developed and developing destinations, limited financial resources, inadequate governance, and remaining gaps in skills and capacities need to be addressed. It is essential to allocate adequate resources and solicit the support of local and international academia for establishing a big data team and enhancing core ICT and big data compilation and analysis skills. New finance vehicles for sustainable infrastructure development and SME renewal should supplement these efforts.

Policies should also aim to establish measurement systems informed by UNWTO's Towards a Statistical Framework for Measuring the Sustainability of Tourism initiative. This provides an integrated information base to better inform sustainable tourism development, facilitate dialogue among different sectors, and encourage integrated, locally relevant decision-making. Incentives are also needed to facilitate data sharing within the private sector, enabling all stakeholders to access big data. This can be done most effectively through public-private partnerships, for which an enabling environment should be created.

Regional cooperation is essential for tourism's recovery from the COVID-19 pandemic and for post-pandemic sustainable development of the sector. In particular, harmonization is needed of laws and regulations on access to regional health data and travel technology. Moreover, as privacy issues permeate borders, a uniform legal data protection framework, such as the Asia-Pacific Economic Cooperation Cross Border Privacy Rules, should be applied throughout the region. Regional bodies and development institutions will be instrumental in facilitating cooperation in all these areas.

I

INTRODUCTION

1. Big Data for Tourism

The ever-increasing amount of data created since the widespread use of the internet in the mid-1990s has generated a robust global conversation in academic circles and boardrooms about using this “big data” effectively and responsibly to further a governance, business, and social agenda. Governments around the world have already begun utilizing big data to improve operations in virtually all domains, including health, transportation, finance, security, and tourism planning and management. In many economies, the coronavirus disease (COVID-19) has accelerated the government’s adoption of big data for pandemic-control measures and impact measurement related to contact tracing, mobility, and health analysis, among others. In tourism, this has translated into greater use of mobility data (Google, Apple), industry data (capacity, searches, bookings), and social media data (sentiment analysis, etc.).

Nevertheless, the use of big data for policy formulation in general, and for tourism in particular, is still in its early stages, especially in the developing economies of Asia and the Pacific. According to Eurostat (2017), full utilization of big data by national tourism organizations, destination management organizations, and national statistics offices will be gradual. In the near term, big data will become an auxiliary data source for official surveys. It will then integrate with traditional data sources in the medium term and become the predominant source in the longer term, although the traditional sources will continue to be used as well.

These impending changes represent opportunities and challenges for the tourism sector in Asia and the Pacific. This report provides insights into what big data is and how it can be leveraged to build a stronger, more resilient, and sustainable tourism sector after COVID-19. The report also highlights the challenges for the tourism sector in taking advantage of these opportunities. This is especially so where information and communication technology (ICT) readiness and capacity is limited and varies considerably among organizations nationally and subnationally within single destinations.

2. The Impact of COVID-19 and Building Sustainable and Resilient Destinations

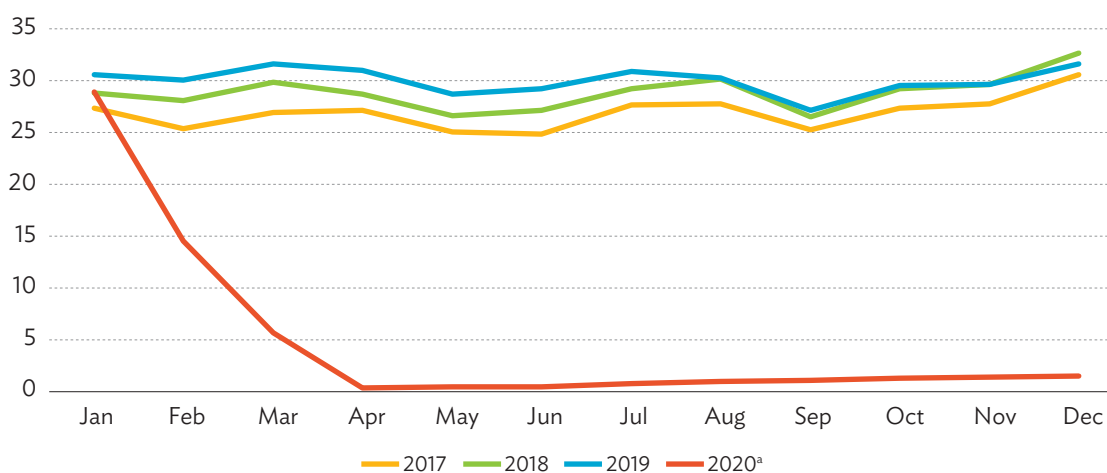
The impact of COVID-19 on global health and economies, as well as social impacts, have been extraordinary, and all have undermined the tourism sector, as widespread and sustained border closures and quarantine requirements take a heavy toll.¹ The International Labour Organization has called the impact devastating. International tourist arrivals worldwide dropped by 73% in 2020, to a level of 30 years ago (Figure 1) (UNWTO 2021a). Asia and the Pacific suffered most, with an 84% decline. Nonetheless, global tourism has adapted before to periods of economic slowdown, such as during previous outbreaks, and is expected to survive this pandemic too. Indeed, the World Tourism Organization's (UNWTO) extended scenarios for 2021–2024 point to a rebound in international tourism by the second half of 2021. However, a return to 2019 levels in international arrivals could take anywhere from 2.5 to 4 years (UNWTO 2021a).



The slump in 2020 happened on the heels of the most successful year ever for the global tourism sector. International tourist arrivals grew 4% to 1.5 billion in 2019, with all regions benefiting from the growth. Growth in Asia and the Pacific was 4% in 2019, reaching 360 million international tourist arrivals, one-fourth of the world's total (Figure 2) (UNWTO 2021a).

¹ As of 1 November 2020, 54% of 217 destinations worldwide had their borders completely or partially closed for international tourism, 31% required a negative polymerase chain reaction (PCR) test, 5% requested quarantine or self-isolation upon arrival, 5% restricted entry to passengers from specific countries, and 3% applied visa-related measures. Only 2% had lifted all COVID-19-related travel restrictions for international tourism (UNWTO 2020a).

Figure 2: International Tourist Arrivals in Asia and the Pacific, 2017–2020
(million)



^a Provisional data.

Source: UNWTO (2021a).

The rapid growth of tourism prior to the pandemic brought considerable benefits. It also created challenges in the social and environmental impacts that could not be ignored. “Overtourism” became a popularly used term, with examples of beach closures due to pollution, overcrowding at key destinations, and water crisis in tourism hotspots around the region. These concerns have reinforced the need for a framework for measuring the social and environmental impact of tourism. UNWTO has been on the forefront of developing guidance and standards. However, applying such frameworks requires new measurement methodologies with indicators empowered by up-to-date data and technology.

More recently, attention has turned to creating and tracking new measures of sustainability in tourism using big data. The widespread collection and use of big data in the public and private sectors provide opportunities for enhanced integration with geospatial data and economic tourism indicators. Emergent concepts such as smart cities and smart destinations also include leveraging big data for enhanced tourism planning and management (Pérez-Guilarte and Quintáns 2019; One Planet Network 2020). These innovative tourist destinations will be supported by cutting-edge technological infrastructure that ensures sustainable development of the tourist areas. They will be accessible to all, facilitate interaction and integration between visitors and the environment, increase the quality of visitors’ experiences at destinations, and improve the quality of life for the resident population (One Planet Network 2020).

This report focuses on the kinds of big data, particularly in economic, social, and environmental areas, which governments need to compile to assist with planning smart destinations.² The sources of these data include tourism big data, non-tourism specific big data (such as credit card spending, mobility data, etc.), and smart sensors big data. However, before a smart destination can be built, significant investment in governance, technology, statistics capabilities, and big data adoption must be undertaken, preceded by a deeper understanding of what big data is and the opportunities it represents. Such an understanding will pave the way for appropriate public, private, and donor partnerships to realize the positive impact of big data on tourism.

The next chapter defines big data generally and in the context of travel and tourism. Chapter III describes a number of case studies on the use of big data for tourism by the governments in Asia and the Pacific. Chapter IV enumerates the key challenges for governments in deploying big data programs for tourism. Chapter V highlights the impact of COVID-19 on the tourism sector and the role big data can play in pandemic recovery. Chapter VI discusses adopting new statistical frameworks that take into account sustainable indicators and new data streams such as big data to build a more resilient and sustainable sector. Finally, Chapter VII offers policy recommendations for a data-driven strategy to achieve sustainable tourism through pandemic recovery and beyond.

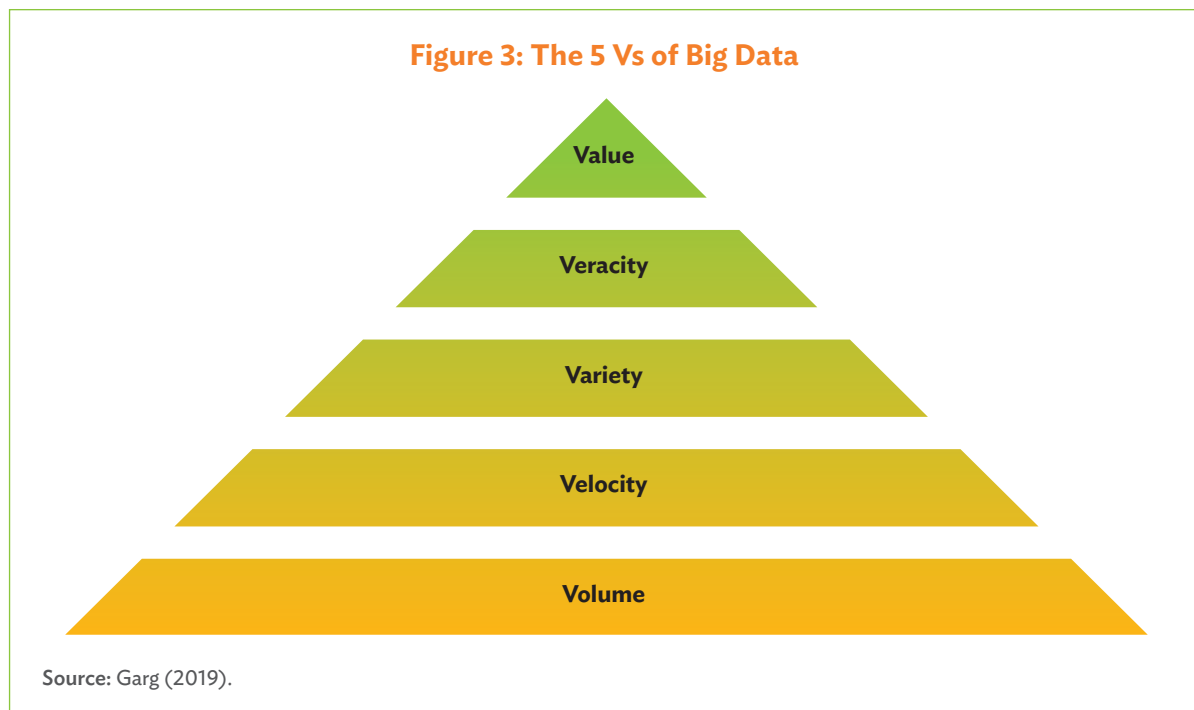
² A smart tourist destination is “an innovative tourist destination, consolidated on a cutting-edge technological infrastructure, which guarantees the sustainable development of the tourist territory, accessibility to all, which facilitates the interaction and integration of the visitor with the environment and increases the quality of their experience in the destination and improves the quality of life of the resident” (DTI n.d.).

II

WHAT IS TOURISM BIG DATA?

1. Defining Big Data

“Big data” refers to the large, diverse, structured and unstructured datasets of information that organizations, people, and machines (sensors) constantly generate and transmit at ever-increasing rates (Ghotkar and Rokde 2016). The data are often characterized by the “5 Vs of big data”: volume, velocity, variety, veracity, and value (Figure 3).



Volume is the amount of data generated and stored that organizations are managing or have access to. Volume has been enormous, especially since the outbreak of COVID-19. During any given minute in 2019, 500 hours of videos were uploaded to YouTube; 208,333 Zoom meetings held; 6,659 packages shipped by Amazon; 1,388,889 video or voice calls made; and 41,666,667 WhatsApp messages sent.

Velocity refers to the speed data are created, stored, analyzed, and visualized and to the “flow” at which data can be retrieved and utilized (Ghotkar and Rokde 2016; BBVA 2020). Indeed, all 500 hours of YouTube videos uploaded every minute and their associated data (URLs, descriptions, etc.) must be organized, categorized, and made available to users as required and almost instantaneously saved as drafts or set live. Velocity is, therefore, measured by the amount uploaded (500 hours uploaded per minute) and then processed (how fast YouTube parses and makes this content available).

Variety refers to the different formats of big data, which fall under two broad categories. **Structured data** comprise clearly defined data types whose pattern makes them easily searchable in relational databases (known as a relational database management systems), and **unstructured data**, which consist of file types like video, audio, image, and social media posts that do not exist in the relational databases and are, therefore, harder to analyze for insights.

Veracity refers to data quality or data integrity. It measures the extent to which data are comprehensive, accurate, and from reliable sources.

Value refers to the extent to which the vast datasets can be processed and understood to provide analytics and insights that improve an organization’s decision-making process and policies.

2. How Big Data Is Generated and Compiled

Table 1 summarizes the ways big data is generated and collected.

Table 1: Primary Locations, Categories, and Sources of Big Data

Big Data Location	Big Data Category	Big Data Source
Internal: Data a company generates, owns, and controls.	Structured data: Comprise clearly defined data types whose pattern makes them easily searchable. Structured data exist in relational databases and account for approximately 20% of all big data. Examples include: <ul style="list-style-type: none"> • dates • phone numbers • credit card numbers • customer names • product names and numbers • transaction information 	Organizational: Traditional data collected and processed by organizations. Examples include: <ul style="list-style-type: none"> • customer relationship management systems • transactional enterprise resource planning data • web store transactions • general ledger data • call centers • website logs • website analytics

continued on next page

Table 1 *continued*

Big Data Location	Big Data Category	Big Data Source
External: Public data or privately held data that the organization neither owns nor controls.	Unstructured data: Big data file types that do not exist in the relational databases and are, therefore, harder to analyze for data insights. Unstructured data account for 80% of all big data such as <ul style="list-style-type: none"> • video • audio • social media posts 	Machine-generated: Data generated from real-time sensors in industrial machinery or vehicles. Examples include: <ul style="list-style-type: none"> • call detail records • smart meters • manufacturing sensors • equipment logs (often called digital exhaust) • trading systems data • remote-sensing data (often using satellite imagery)
		Social data: Also known as human or user-generated content data, this is the vast amount of social media generated daily. Data in this category are usually unstructured. Examples include: <ul style="list-style-type: none"> • customer feedback streams • micro-blogging sites such as Twitter • social media platforms such as Facebook • video platforms such as YouTube

Sources: Bekker (2017); Faber and Gaubert (2019); Ghotkar and Rokde (2016); Muse (2017); Oracle (2013); and Taylor (2018).

3. Data Useful for Tourism

The types of data most useful for tourism can be divided broadly into tourism big data as those generated by tourism operators and online travel which have evolved with shifts in the distribution of travel products as well as social media, and non-tourism specific big data, including those generated by mobile technologies or smart sensors which cover data such as mobility or credit cards that provide information on spending patterns and trends.

A. Big Data from Tourism Operators and Online Travel and Social Media

Tourism operators and online travel big data consist of the enormous datasets collected by tourism digital platforms when consumers engage in online travel. Online travel refers to the business-to-consumer and consumer-to-consumer digital content engagement behavior (web and app analytics), search behavior, reviews, bookings, and social postings made before, during, and after travel on digital travel platforms and social media. Behind these consumer-facing platforms, there is also a business-to-business big data component, as the global online travel ecosystem is powered by a vast network of interconnected digital platforms that facilitate bookings and business operations.

The data types especially important for the tourism industry include the following:

Inventory data, including flights, hotel rooms, tours, car rentals, transportation services, or any other travel product for reservation or sale that are generated by organizations and are usually highly structured. These data provide information

on price fluctuations and product descriptions, allowing marketing efforts to be tailored to specific locations during specific periods and providing input for forecasting demand.

Loyalty programs such as Skyteam, Star Alliance, and Oneworld in the airline industry, generate highly structured and centralized data accessible to businesses in real time. These data, which also include large cross-industry and cross-business rewards, provide information on the relationship between incentives and purchasing behavior, how consumers engage with multiple products, and the evolution of purchasing habits as consumers age.

Bookings or reservations data captured at the time of sale of a travel product contain information on the travel product, dates of travel, personal information about the travelers, the point of origin, destination, and purchase price and method of payment. These data are captured by organizations and are highly structured. They can be utilized to understand the success of current campaigns, promotions, and user experiences that resulted in actual sales. They reveal information on the purchasers, allowing businesses to create better and more targeted advertising campaigns addressed to them. Booking is an upstream action that can lead to further downstream purchases. That is, once a booking is confirmed for any stage of the travel, aggressive marketing for ancillary services can begin with greater confidence.

User ID data, which are captured by organizations and are structured, include login or username, web cookies, device ID, or third-party account login (Google, Facebook, or other e-mail). Such data can help marketing companies and platforms create stronger marketing “audiences,” identifying segments of consumers who share demographic, psychographic, or observed similarities of interests. This allows targeting these consumers with better incentives, remarketing, and email marketing. Given the extremely sensitive nature of such personal information, the storage, control, and processing of user ID data are highly controlled and lie at the center of big data cybersecurity and safety discussed later in this report.

Web analytics data, captured by organizations and usually highly structured, bring together the measurement, collection, analysis, and presentation of data to understand and optimize how websites are used. If expanded to cover mobile apps or other digital assets, the term may be referred to as digital analytics.³ Web analytics tools track virtually any statistic that could be measured as a result of a website or app visit and data unintentionally left by users. Common metrics include time on specific pages, geography, user flow across pages, sources of the visit such as marketing campaigns, referring websites, device type, content engagement, shopping cart entry and abandonment rates, conversion rates, and downloads, among countless others. Web analytics allow companies to create accurate customer personas based on real (not perceived) customer action, then refine their marketing efforts and on-site or in-app user experiences to optimize revenue and retention.

³ As defined by At Internet’s Glossary: Web Analytics. <https://www.atinternet.com/en/glossary/web-analytics-2/>.

Search data, also captured by organizations and highly structured, refer to the search criteria users input when searching on digital platforms. They constitute one of the richest datasets in any industry and are particularly coveted in travel as they show what consumers are actually searching for. Online travel platforms often pull their inventory from centralized distribution systems known as global distribution systems (detailed below). As a result, consumers' searches are captured not only by the search platform (e.g., Kayak.com) but also on the global distribution systems that Kayak is pulling inventory from. Global distribution systems receive millions of search calls a day, giving them a rich comparative search dataset across the most prominent online travel suppliers. Moreover, general search data from websites such as Google accurately signal customers' earliest possible strong travel intent, allowing businesses to market travel products to them. Search is a strong indicator of intention because it is *an active action* by potential customers who are also highly targetable using modern digital advertising techniques. Highlighting the importance of search to the tourism sector, most of the more than \$11 billion spent on marketing by Expedia Group and Booking Holdings in 2019 was for performance marketing on Google search ads (Lerner 2020).

Travel reviews are left by travelers about travel products and services on travel platforms, such as Tripadvisor and Google, and generated heavily on online travel agents. These can be both structured (star ranking systems, prefilled answers) and unstructured (text, image, even video). Travel reviews yield insights into travelers' sentiments about specific experiences, destinations, or brands.

Social media content users are able to share personal information, documents, videos, and photos, while often using social media for messaging (Dollarhide 2020). User data are highly unstructured, but can be used to analyze behavior and group users into increasingly accurate "audiences" based on biographic data and interests derived from the content they share and engage with.

Operations refer to the software or "software as a service" companies that assist travel and tourism companies with management and operations. Hospitality and aviation companies around the world need comprehensive software support with managing reservations, workforce, assets, such as buildings or fleets, and customer databases. Operations data are structured data generated by organizations and machines (sensors) from different assets, such as airplanes, cars, and hotel equipment. Analysis of these datasets can provide insight on improving operations and top-line performance.

B. Shifts in Global Distribution of Travel Products

The system of travel product distribution has evolved and currently involves several players. Online travel has expanded to cover virtually every aspect of the travel experience, the global online travel and global distribution systems are vast (Box 1), and big data are varied, as captured by the numerous tourism operators and online travel outfits (Table 2). Global revenue from online travel amounted to \$570.3 billion in 2017 and a projected pre-COVID-19 revenue of \$1,134.6.2 billion by 2023 at a compound annual growth rate of 13.2% (Market Research Future 2019). Already, online travel accounts for nearly 50% of total global bookings and is expected to continue growing faster than the overall travel market (Business Wire 2019).

Increasing consumer reliance on search platforms such as Google has resulted in two major shifts in big data for the tourism sector. First, big data moved from being fully organizationally driven to travelers themselves generating huge pools of intentional and unintentional data relevant to tourism. Second, travel suppliers and resellers like online travel agencies began spending billions of dollars on

Box 1: Size of Selected Online Travel Agency and Metasearch Platforms

Tripadvisor. This metasearch and review site (NASDAQ: TRIP) reports being “the world’s largest travel platform, helping 463 million travelers each month make every trip their best trip. Travelers across the globe use the Tripadvisor site and app to browse more than 867 million reviews and opinions of 8.7 million accommodations, restaurants, experiences, airlines, and cruises.”^a

Expedia Group (NASDAQ: EXPE) says it has more than 200 travel booking websites available in more than 70 countries, with 1 million hotel properties, 500 airlines, 35,000 activities, 175 rental car companies, dozens of cruise lines, and 1.8 million listings on HomeAway.^b In 2019, the two biggest online travel agencies, Expedia Group and Booking Holdings, had a combined market cap of \$100 billion (Wyman 2019).

Trip.com Group. Taking a prominent example from the People’s Republic of China (PRC), Trip.com Group Limited (Nasdaq: TCOM) is another leading online travel agency, and consists of Trip.com, Ctrip, Skyscanner, and Qunar. Generating about \$105 billion in gross merchandise value in 2018 for Chinese consumers alone, the company has more than 1.4 million hotel and hostel properties and 1.2 million vacation rental properties around the world; more than 2 million global air routes connecting over 5,000 cities in over 200 countries and territories; train tickets across 33 countries; bus tickets connecting more than 3,000 bus stations in the PRC; and vacation packages, guided tours, and in-destination services including insurance, visa services, attraction tickets, and local activities, covering over 3,000 destinations in more than 160 countries and territories.^c

Amadeus. The global distribution system Amadeus reported revenue of over \$5.5 billion for 2019, having processed 647 million travel agency bookings and over 1.9 billion passenger boarding during that year (Amadeus 2020).

^a See the “About” section on Tripadvisor.com.

^b See Expedia Group “Who We Are” at <https://www.expedia.com/>.

^c See Trip.com for information.

Source: Authors.

direct marketing campaigns aimed at consumers on the primary search and social media digital platforms they used, leading to the emergence of the so-called “gatekeepers,” such as Google and Facebook that travel advertisers use to reach travelers directly.

The “gatekeepers” not only have cross-sectoral visibility on consumer habits, spending, and web engagement outside of travel, but given the billions of travel advertising dollars spent annually on their platforms, they also have information on the success and business practices of all travel advertisers—big and small—who use them to reach customers. Given these multiple upstream strategic advantages and the fact that they own the proverbial “playing field” of travel competition, “gatekeepers” wield enormous leverage in the industry (Sheivachman 2017).

Apart from online travel agency and metasearch platforms, the world of tourism big data also includes travel marketing platforms and travel and tourism business intelligence companies.

Travel marketing platforms collect data on travelers’ search and booking behavior across vast networks of websites. They work by setting up commercial agreements with other website and app owners who allow them to place tracking pixels and cookies and potentially advertising space on their digital assets. Using the web-analytics and user ID data generated, these platforms assist in creating highly targeted travel marketing campaigns, such as display ads, video, Facebook campaigns, retargeting, or virtually any other ad form. The platforms are powered by advanced targeting algorithms and programmatic bidding technologies. Unlike traditional web analytics that may only be limited to tracking data for only one or just a few websites, these platforms are able to generate powerful audience segments across their networks. As such, they help travel product suppliers generate better advertising return on investment through cross-site ad targeting, campaign measurement and attribution, audience segmentation and activation, and ad frequency capping (Sweeney and Álvarez 2020).

Travel and tourism business intelligence companies aggregate, organize, and analyze available data either by way of commercial agreements with private dataset owners or by advanced web scraping and other tools. These companies then create and package big data knowledge products, including analytics dashboards, stand-alone reports, or consulting products such as marketing or market entry strategies. Their prepackaged dashboards, knowledge products, and consulting services make data actionable and accessible for tourism planning by governments and businesses that may lack the skills to organize and analyze complex big data or lack access to necessary data.

Table 2: Big Data Captured by Tourism Operators, Online Travel Sources, and Social Media

Big Data Provider	Key Data Captured	Example Companies
Suppliers	Inventory, loyalty programs, bookings, user IDs, web analytics, on-platform search	Accor, Marriott, Delta Airlines, Korean Air
Global distribution systems	Inventory, loyalty programs, user IDs, on-platform search	Amadeus, Sabre, Travelport
Traditional travel agents	Inventory, loyalty programs, web analytics, on-platform search	Amex Business Travel, BCD Travel, Carlson Wagonlit, Flight Centre Travel Group
Online travel agents	Inventory across suppliers, loyalty programs, bookings, user IDs, web analytics, on-platform search, on-platform advertising, travel reviews	Expedia Group, Booking Holdings, Trip.com Group
Travel metasearch and review sites	Inventory across suppliers, user IDs, web analytics, on-platform search, on-platform advertising, travel reviews	Skyscanner, Kayak, Tripadvisor
Search and social media marketing platforms	Inventory across suppliers, user IDs, web analytics, on-platform search, on-platform advertising, travel reviews, non-travel related search, non-travel related advertising, non-travel related purchasing, non-travel related reviews	Google, Facebook
Operations software	Asset management, human resources, web analytics, reward schemes	Ramco Aviation, Amadeus Altéa
Business Intelligence ^a	Social media analysis, travel review analysis	TCI Research, Cirium, ForwardKeys, STR, Rainmaker, Mabrian
Travel marketing platforms	Web analytics, user IDs	Sojem, Travel Audience, Adara

^a Commonly has access to any other datasets by way of commercial relationships with other data providers. Source: Berrigan (2019).

4. Non-Tourism Specific Big Data

There are big data providers from other industries beyond travel and tourism whose importance in the tourism sector is either already well established or beginning to emerge, as they are critical to measuring mobility, expenditure, or use of resources. The big data they collect can yield important insights into tourism planning and decision-making (Table 3). These data are among the sources most commonly used for compilation of official statistics on travel and tourism and for generating other useful business insights (Eurostat 2017).

Telecommunication companies generate large datasets useful for mapping and understanding tourism flows. By capturing user locations at a variety of touch points, telco data are used to aid tourism local, provincial, and even national planning, given their high accuracy and already proven multiple uses for tourism (Brezina 2019). These uses include indicators, such as the number of trips/visits, nights, and unique

Table 3: Key Big Data Captured by Non-Tourism Specific Providers

Big Data Type	Key Data Captured	Example Companies or Sources
Telecommunication companies	Calls, mobile data, geotagging	Mobile network providers (various)
Financial services and credit card	Transaction amount, transaction location, transaction type (products), User ID, volume of transactions	Mastercard, Visa
Retail	Products purchased, volume of transactions, location of purchase	Mastercard, Visa
Smart cities sensors	Car parking, noise monitoring, water usage, traffic surveillance, crowd surveillance, facial recognition, electricity use, and air pollution reporting	Cisco, Schneider Electric, Siemens, Microsoft, Hitachi, Huawei, Ericsson, Toshiba, and Oracle ^a
Climate change	Air quality, carbon emissions, water pollution, deforestation, coastal or reef degradation	Multiple government ministries, environment-focused NGOs, the UN, Smart Cities Sensors
Geospatial data	Location, attribute, and temporal information	Satellite imagery and elevation data at 30 meter resolution are available via Landsat
Health	Patient data, COVID-19 test timing and result	Hospitals and clinics, public health government agencies, CommonPass or other health passports
SuperApps	Communications, movement, food, social, financial, and retail	WeChat, Line, Gojek, Grab, Meituan and Dianping

NGO = nongovernment organization, UN = United Nations.

^a Top 10 companies helping build smart cities around the world.

Sources: Bremner (2019) and Smart City Hub. <https://smartcityhub.com/technology-innovation/the-top-ten-companies-that-build-smart-cities>.

visitors; place of residence; aggregation of time and space (different level of administrative units, grid); duration of trip/stay (same-day/overnight trip); main destination, secondary destination, transit pass-through; collective movement patterns; and even repeat visits (Eurostat 2014). They are important to both domestic and international tourism and can play a critical role in flow and congestion management.

Financial services companies, such as payment processing platforms and credit card companies, process and collect billions of transactions every day in virtually all destinations around the world. Once aggregated and anonymized, payments data can deliver deep, timely insights into localized market spending by travelers in the destination (Mastercard n.d.) and provide a deeper understanding of how tourists act “offline” in destinations based on the payments and transactions they make across all products and services (Eurostat 2017).

Retail data are reported by retailers or automatically collected and aggregated by the various point of sale or other digital systems that they use. UNWTO reports that retail is one of the major categories of tourist expenditure, thus making shopping an increasingly

relevant component of the tourism value chain (UNWTO n.d.a). Retail data can shed light on tourism flows as they can be correlated with tourist foot traffic or route selection. This also makes retail data useful for measuring dispersal efforts.

Smart sensors, used to monitor and track various municipal services, generate massive data every day on car parking, noise monitoring, water usage, traffic surveillance and number plate recognition, crowd flows, electricity use, and air pollution reporting, among others (Spider 2018). Smart Sensors help better inform urban planning and destination management. Clearly, the better tourists and local interactions with destination are understood, the more informed tourism development can be.

Climate change data on air quality, carbon emissions, water pollution, deforestation, coastal or reef degradation, and the like are essential in addressing public demand for greater accountability from all industries on climate change. National tourist organizations, destination management organizations, and tourism businesses will need to start accounting for the environment in all reporting and future development plans, and increasingly more climate change big data streams will need to be developed and analyzed to ensure the tourism and environmental goals can be met.

Geospatial data combine location information (usually coordinates on the earth), attribute information (the characteristics of the object, event, or phenomena concerned), and often also temporal information (the time or life span at which the location and attributes exist) (Stock and Guesgen 2016). A significant portion of big data is actually geospatial data, and the size of such data is growing at least by 20% every year (Lee and Kang 2015). The potential use of geo-referenced information for destination planning has also been widely advocated by UNWTO (UNWTO 2018a). The data generated from the local level are required to manage the carrying capacity of destinations as well as the impact on the environment and society, including local residents (Gauche 2019). Geospatial data analysis can provide opportunities to enhance the integration of data across all dimensions at all scales and support destinations to create more transparent and timely communication and decision-making.

Health data collected by health-care providers, public health government agencies at local and national levels, and insurance companies have demonstrated their usefulness during the COVID-19 pandemic. The understanding that travel is a primary vector of transmission of COVID-19 necessitating social distancing and border closures led to the total global shutdown of the tourism sector. In the short term, government health, transportation, and travel ministries will need to work together to harmonize the policies and technologies that allow for the reopening of travel, both domestically and across borders. This includes compiling robust data on contact tracing, testing, and health passports. In the longer term, post-pandemic travel and tourism planning and public health protocols need to better incorporate crisis management for large-scale biological events.

SuperApps, the multifunctional mobile apps, such as WeChat, Line, Gojek, Grab, Meituan, and Dianping, collect vast amounts of data on their users across a spectrum of economic and social activity, such as communication, lifestyle, travel, social, financial, and retailing in a centralized platform (Bremner 2019). They have also emerged as powerful marketing platforms to motivate source market expenditure. As a result, partnerships between these companies and national tourism organizations and destination management organizations are on the rise. Further, as increasingly more payments for local activities take place through such apps, push notification alerts and other messaging techniques can be used to motivate traveler behavior while in the destination.

III

HOW GOVERNMENTS ARE USING TOURISM BIG DATA

This section provides a general overview of the models of engagement between official tourism organizations and big data providers, before highlighting case studies of tourism big data being used for both destination planning and management.

1. Models of Engagement

Marketing and promotions partnerships between tourism authorities and leading online travel agencies, metasearch, and big data marketing platforms are the most common types of collaboration for the exploitation of big data for tourism. Significant financial investments and skilled marketing personnel are sometimes required to exploit such data, but setting up native big data marketing programs are even more costly. In effect, marketing partnerships represent the lowest bar to entry.

One such partnership is that between the Tourism Authority of Thailand and Expedia on multiple initiatives, allowing the tourism authority to run campaigns across Expedia's numerous web platforms with over 750 million views per month. This helps the authority achieve its goals of attracting more premium and first-time international tourists to Thailand, balance traffic flows during off-peak and high seasons, and disperse tourists to second-tier provinces, such as Chiang Rai, Satun, Mae Hong Son, and Trat (Worrachaddejchai 2019).

The Okinawa Prefecture in Japan, too, has worked with Travel Audience, an Amadeus company in 2017, to increase bookings from select European markets. Targeting consumers from the United Kingdom from mid-February to mid-March that year, Travel Audience applied its data-driven marketing platform to target the most likely-to-book consumer audience segments on partner online travel agency sites. After launching the campaign, Travel Audience's algorithms took over and continually optimized the performance of the ads as they learned in real time what combinations of ads and users led to the highest engagement and bookings. This coordinated campaign effort resulted in the ads being shown over 2 million times, which, in turn, resulted in a 450% increase of British travelers in only 1 month (Travel Audience 2017).

A. Case Studies: Government-Led Big Data Programs with Application to Tourism

Moving up to higher levels of big data engagement, destinations in the region are building robust government platforms and programs that combine their own public-sector data with data from private-sector partners. These case studies showcase how these programs are being used to develop better marketing strategies and product development, managing destinations for tourism flows, direct planning for smart cities, and inform economic and tourism policy development.

➤ Singapore—The World’s Smartest City

➤ Lead Agency: Singapore Tourism Board

Background

The Smart Nation Singapore (2018) initiative was launched in late 2014, focusing on health, transport, urban solutions, finance, and education. Since then, Singapore has become a global leader in smart initiative spending alongside New York, London, and Barcelona—all of which are investing more than a billion dollars per year (CIO 2019). After just 5 years since launching the initiative, Singapore was awarded World’s Smartest City by the IMD Smart City Index in 2019 (Yee 2019).

Use of big data for tourism

In 2018, the Singapore Tourism Board (STB) announced that it was developing the Singapore Tourism Analytics Network (Stan) platform to power deeper insights into data from their own sources, other government agencies, and industry big data providers it partnered with (Chow 2018). In 2019, STB reported that Stan had integrated over 20,000 internal data domains and signed 15 data-sharing agreements with some of the largest data providers in the world, such as Grab, Tencent, and Expedia (STB 2019). STB used Stan to analyze key source markets and uncovered trends about Chinese and Indonesian tourists, based on which STB was able to help retailers make the campaign and product adjustments accordingly to better attract these demographics (GovInsider 2018). STB also used Stan to analyze hotel habits for travelers and the information uncovered was shared with the trade, allowing hoteliers to design packages that better captured traveler demand within individual properties and enhanced cross-selling among their own or partner hotels (GovInsider 2018).

People can access high-level datasets on Stan, including tourism statistics and big data. STB plans to roll out updates to the platform, increasing the number of datasets available to the public, including anonymized geolocation information to provide insight on what tourists do while in Singapore. Further, the platform will eventually help companies benchmark their performance against their peers and better understand their target audience (Tay 2020).

➤ Macau, China—Crowd Forecasting and Dispersal

➤ Lead Agency: Macao Government Tourism Office

Background

In 2017, Macau, China entered into a 4-year partnership with Alibaba Cloud, a subsidiary of Chinese tech giant Alibaba Group, to build Macau, China as a smart city, with the first phase focusing on cloud computing, smart transportation, smart tourism, smart health care, smart city governance, and capacity development (Alibaba Cloud 2017). The Macao Government Tourism Office outlined three strategic goals to guide their work with Alibaba: optimize visitors' travel experiences before, during, and after trips; obtain insights into travelers' behavior through in-depth analysis of big data; and monitor, divert, and disperse visitor flows at tourist districts and congested areas.

Use of big data for tourism

One of the first projects launched was a smart application for visitor flows that monitors crowds in real time. Powered by Alibaba Cloud's predictive analytics, the platform helps travelers plan their trips by providing real-time and predictive crowd estimates at 20 of Macau, China's most popular attractions in 4-hour, 24-hour, and 7-day increments. Based on crowd volumes, the platform assigns the location a ranking from "comfortable" to "heavily congested" (MGTO 2019). Working hand in glove with Macao, China's Public Security Police Force, big data inputs to the platform include real-time arrivals figures from immigration, Amap data (Alibaba's map application), weather and events (MGTO 2019).

The tourism office's big data platform is able to analyze footage of car license plates from the Public Security Police Force's traffic monitoring cameras. The Public Security Policy Force has also been using special cameras for enhanced crowd and congestion analysis during peak tourist periods. Better crowd density and visualization tools allow the force to take proactive measures before crowds become too large (Macau Daily Times 2020).

This kind of data provides traveler insights on their source market and the information about them captured by immigration, while also enabling a mapping of their journey around the city. Furthermore, the tourism office's platform is interfacing with data from Amap to monitor tourism flows and places searched for and visited, providing even more dimensions to understanding how tourists interact with their destination.

➤ Thailand—Smart Tourism

➤ Lead Agency: Tourism Authority of Thailand

Background

To transcend the middle-income trap, in 2015 the Thai government announced an ambitious development plan under the banner of “Thailand 4.0” (Bangkok Post 2020). Its goal was to move the country from a production-based economy to an innovation economy, and the plan included a 20-year National Digital Economy Master Plan (Aditya 2020). Both big data analytics and smart tourism fall under the umbrella of Thailand 4.0. Nationally, the “Tourism Smart Data, The Time Is Now” initiative was launched in late 2018 to support strategic planning and data-based decision-making; integrate the collaboration of all sectors in the supply chain; offer a great travel experience for all groups of travelers; and channel income to the local community (Khaosod 2018; TAT Newsroom 2020).

Use of big data for tourism

Nationally, a live dashboard is available for public use, with dynamic tourism statistics by province. Subnationally, Phuket is one destination in Thailand that has really embraced this push. The island destination receives more than 9.29 million visitors per year, or an average of 25,452 visitors per day, making it the destination with the highest tourist density per square mile in the world (The Phuket News 2019). To effectively manage such volumes of tourists, Phuket has installed over 1,000 free WiFi hotspots that give tourists access to high-speed internet and a CCTV vehicle license plate recognition system (The ASEAN Post 2018). Other smart sensors are being employed for ocean surveillance and safety. Lifeguards and other safety service personnel benefit from smart tools for ensuring the safety of the 50,000 people that go out to the sea every day, monitoring the beaches, boat conditions, and locations, and the weather (Chuenniran and Sattaburuth 2019). The goal is to eventually integrate the multiple tourism and other big data sources into a centralized database to allow greater data visualization and analysis.

➤ Japan—Visualizing Economic Big Data for Tourism

➤ Lead Agency: Ministry of Economy, Trade and Industry

Background

In 2015, the ministry and the secretariat in charge of vitalizing the local economy launched the Regional Economy and Society Analyzing System (RESAS), a groundbreaking tool that creates easy-to-understand visualizations of a wide variety of economic and social data. Big data is compiled from government agencies and the private sector on industrial structures, demographic movements, and population flows (METI 2017). RESAS helps in regional revitalization, e.g., creating autonomous and sustainable communities based on unique local characteristics (Apolitical 2018).

Foreign tourist arrivals contribute to and are considered essential for revitalization of Japanese regional economies (Tanaka 2018). Tourist arrivals during 2013–2018 grew an average 25% annually (before the pandemic), making Japan the third-most visited destination in Asia (UNWTO 2019). Prior to the pandemic, the government's goal was to raise the number of arrivals to 40 million in 2020 and 60 million in 2030 (METI 2016a).

Use of big data for tourism

The Ministry of Economy, Trade and Industry has optimized the use of RESAS for tourism-specific data, allowing searches aimed at both macro-analysis, including changes in industrial structure, and micro-analysis, such as determining how long tourists stay in popular hotspots, or tracing the history of individual stores and offices in the shopping areas of the region. The grid analysis allows users to obtain information regarding visitors' movement patterns and monthly and hourly visits to locations in each grid, set at intervals of 500 million, so they can identify popular stopping places and design sightseeing routes which connect these sites. Spending habits of tourists by nationality are also recorded for developing marketing strategies tailored to the tourists' reasons for visiting specific regions. Since 2017, Global Blue TFS Japan, a tax-free shopping and processing service, has provided duty-free shopping data on RESAS, allowing visual review of duty-free shopping trends (Travel Voice 2017) and the visualization of the demography of international duty-free shoppers by prefecture. RESAS can also be used by companies to create business opportunities, or by regional residents to improve their communities. The national government also supports activities which utilize RESAS. It holds idea contests and workshops to discuss policies, so that a wide range of people can create ideas freely using RESAS and contribute to building their communities.

To support the expected tourism growth, the ministry established the Omotenashi Platform, an IT-based system that encourages service providers to collaborate with each other and provide foreign visitors with high quality services (METI 2016a). Using the Omotenashi Platform, businesses can access, share, and utilize personal data provided

consensually by tourists, while overseas visitors to Japan are able to enjoy advanced services and accommodating environments. Through this platform, service providers can collect and analyze these data—which could be challenging to obtain by a single business or local authority—to enhance service quality, develop new tourism products, and cultivate new markets that cater to tourists’ needs and preferences. The ministry has also been developing rules and regulations for the Omotenashi Platform, including privacy policies and terms of use for concluding agreements with platform users, standardizing formats for available data, and procedures for accessing the platform in order to facilitate information distribution (METI 2016c).

B. Case Studies: Complementing Official Tourism Statistics

Some destinations are using big data to generate or complement official tourism statistics. Prominent among them in the region are Indonesia, Australia, and New Zealand.

➤ Indonesia—Mobile Positioning Data for Official Tourism Statistics

➤ Lead Agency: Statistics Indonesia

Background

In recent years, Indonesia has emerged as a global leader for using mobile positioning data in tourism. Beginning in 2016, Statistics Indonesia began using mobile positioning data from the archipelago’s largest mobile network operator to supplement its official surveys. Prior to using mobile positioning data, there were multiple coverage gaps for data on international arrivals, domestic tourism, and outbound travel (BPS 2019), and not all the data were accurate and timely. The border-crossing surveys used by the mobile positioning data proved not only expensive (requiring a staggering 8,000 enumerators to execute and 6 months to process the results [BPS 2019]), but could only take place during a limited period each year, meaning the results for the rest of the year had to be estimated (Lestari et al. 2018).

Obtaining and using big data for tourism

With many entry points to the country and tourists’ phones constantly switching between network providers, it was challenging for Indonesia to determine how many tourists actually enter the country from the neighboring areas. To address the issue, Statistics Indonesia entered into a commercial relationship with Positium—a company from Estonia that specializes in mobile positioning data for official statistics and provides innovative data solution. Using anonymized data from mobile network operators, Positium turns billions of location points into meaningful and timely statistical indicators (Positium 2019). The Indonesian project provided new information on roaming counts and roamer overlap between the two major telecom providers, enabling Positium to find out the real roaming market share, an important element in the accurate calculation of tourism indicators (Saluveer 2019).

Output and/or outcome

Mobile positioning data is not easy, as it needs a good methodology and quality assurance framework (Lestari et al. 2018), but the impact on Statistics Indonesia's ability to get more accurate and more frequent data has been astounding, as are some of the business results owing to the clarity provided by the enhanced data. The statistics office is now able to publish data at the regency level, requiring only eight data scientists to process the data (BPS 2019). It has also found out that arrivals from neighboring countries amount to 30% of total arrivals (Positium 2019), the number of the people crossing the border from Timor-Leste is large, and most visit for shopping. Timor-Leste has since been rightly established as a top-five source market, increasing the emphasis on and investments in catering to this previously overlooked and organically occurring market (Positium 2019). The statistics office is now also able to complement preexisting immigration information with origin information (province and regency) and destination information (where to) and publish the data monthly (Positium 2019).

➤ **Australia—Global Leadership in Use of Big Data in Official Statistics**

➤ **Lead Agency: Australian Bureau of Statistics, Tourism Research Australia**

Background

Australian official tourism statistics are currently produced by the Australian Bureau of Statistics and Tourism Research Australia. The statistics bureau provides data on tourism's contribution to the economy for the annual Tourism Satellite Accounts, and Tourism Research primarily collects Australian tourism data via a quarterly National Visitor Survey and International Visitor Survey. These ask domestic and international visitors about expenditure, places visited, activities, accommodation, transportation, and demographics (Queensland Government 2020).

Australia has led the region leveraging the potential of big data in official statistics. After releasing a Big Data Strategy in 2014, the statistics bureau launched the Big Data Flagship Project to systemize the research and development efforts that will build a firm methodological foundation for the mainstream use of big data in statistical production and analysis. This project covers the collection and analysis of big data from various sources including environmental scanning, satellite sensor data, mobile device data for population mobility, machine learning for predictive modeling, advanced visualization techniques for exploratory data analysis, and automated content analysis of complex administrative data. The Australian Bureau of Statistics has also collaborated with leading Australian researchers on data analytics to advance the research objectives of this project (Tam and Clarke 2014).

Use of big data for tourism

In 2017, Tourism Research Australia partnered with Data61, a nonprofit helping industries transform through data science and research and technology development (Data61 2019). Through this partnership, Tourism Research and Data61 reviewed the data landscape to determine requirements of tourism data consumers, how well official data meet those needs, and the suitability of alternative data sources for use in tourism statistics (Walker et al. 2017). They identified the major data gaps in their current statistics that can be complemented by using big data, such as visitor pathways, visitor sentiment and actual experience, non-travelers (and possible motivators), and granular data.

The Australian Bureau of Statistics has been exploring the use of anonymized mobile phone data from commercial providers for tourism statistics to understand internal movement, commuter flows, and population distribution, and to estimate characteristics of big data population sectors (Johns, Compton, and Wobcke 2018). In addition, in response to COVID-19, the Bureau of Statistics (ABS 2020) is looking at big data sources to inform official statistics, particularly aggregated and de-identified mobility data to understand changes to population movement, business activity, and reductions in travel.

➤ **New Zealand—Using Electronic Card Transaction Data**

➤ **Lead Agency: Ministry of Business, Innovation and Employment**

Background

In 2011, the Ministry of Economic Development produced New Zealand's first-ever Tourism Data Domain Plan, which identified accurate estimates of regional tourism spending in New Zealand as one of the major gaps in the national tourism statistics (Webster 2018). In 2012 and 2013, the Ministry of Business, Innovation and Employment, which monitors the New Zealand government's tourism research program, launched two innovative regional tourism data collections that utilize electronic card transaction data. The regional tourism indicators and regional tourism estimates provide detailed, regionally specific insight into domestic and international tourist spending behaviors. Prior to the introduction of the indicators and the estimates, there were no specifically designed data sources for measuring regional tourism. Government and stakeholders were dependent on data from the International Visitor Survey and the Domestic Travel Survey, which were designed to give national estimates and which lacked the statistical power to produce reliable estimates at subnational levels (Burson and Ellis 2014).

Obtaining and using big data for tourism

The Ministry of Business, Innovation and Employment purchases electronic card transaction data from Marketview Ltd, a commercial data provider specializing in the management and analysis of electronic card transaction data for consumer expenditure (Burson and Ellis 2014). The ministry receives anonymized aggregated values for total card spending and transaction counts which are broken down by territorial authorities, tourism satellite account product category, and country of origin (international) or region of origin (domestic). The full dataset is updated monthly to reflect new information about merchants. Marketview sources the data from two payment networks: Paymark and Bank of New Zealand.

The regional tourism indicators use aggregated electronic card transaction data classified by period, cardholder origin, merchant location, and merchant industry (Burson and Ellis 2014). The data are published monthly as transaction counts or spending indexes using any combination of these measures. Beyond tracking long-term growth and changes in tourism spending, the regional tourism indicators are a valuable tool for assessing the impact of marketing efforts and other factors affecting tourism spending. With less than 1-month delay between the close of the reference period and publication of the data, the indicators provide policy makers and tourism operators with regular and timely updates of tourism spending and growth at a pace and depth never before achievable.

The regional tourism estimates also enhance the electronic card transaction data through a combination of data sources and modern statistical techniques to produce estimates of absolute spending that can be disaggregated by year, territorial authority, industry, and by visitors' country or domestic region of origin. The estimates provide regional yearly dollar estimates of tourism spending using the regional tourism indicators, weighted using the International Visitor Survey and provisional data from the Tourism Satellite Account (Webster 2018). Beyond regional tourism indicators and estimates, estimates of monthly regional expenditure on tourism from both international and domestic consumers are provided (Webster 2018).

Outcome and/or output

The transaction datasets mentioned above are publicly available and have become widely used in the New Zealand tourism sector to assist regional tourism stakeholders make informed planning and investment decisions as well as inform government policy development related to regional and seasonal dispersal.⁴ The data were particularly instrumental in showing the recovery from the November 2016 Kaikoura earthquake, driving government policy in this area, and the impact of the DHL British and Irish Lions' rugby tour in June and July 2017 (Webster 2018).

⁴ The transaction datasets are available at MBIE (2021).

IV

BIG DATA CHALLENGES AND LIMITATIONS

Despite the partnerships and big data programs highlighted above, significant technological, organizational, institutional (including legal), and financial challenges remain related to big data implementation and management by governments in the region. These include data privacy, cybersecurity, skills capacity gaps, cost, access and private sector control, and inclusion of small and medium-sized enterprises (SMEs) (Eurostat 2017; Pérez-Guilarte and Quintáns 2019). Moreover, limitations inherent in the nature and extent of the data collected and the modalities of their compilation need to be addressed.

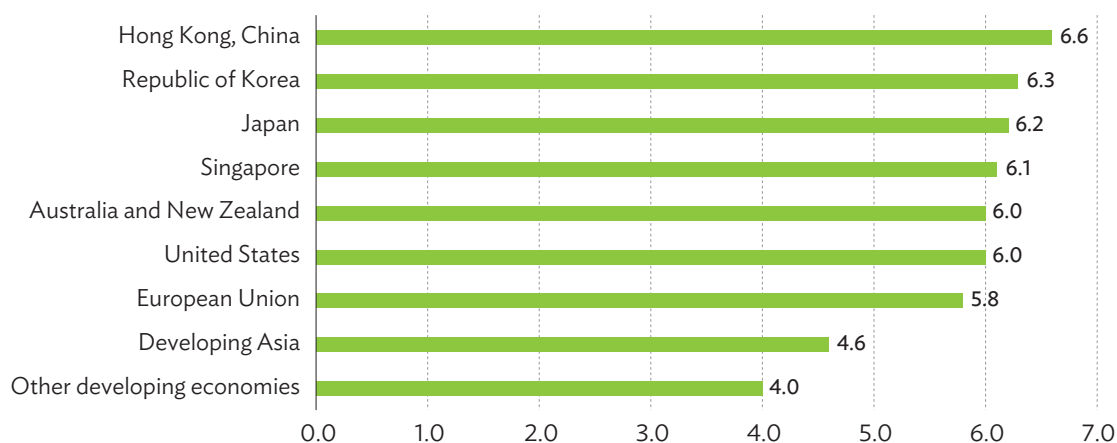
1. Challenges

A. Overall ICT Readiness and Cost

The OECD (2001) defines “digital divide” as the gap in access to information and communication technology (ICT) between individuals, households, businesses, and geographic areas at different socioeconomic levels. In Asia, this divide is evident in economies’ ability to deal with big data for tourism. The Travel and Tourism Competitiveness Index 2019 gives ICT readiness in developing Asia a regional average score of 4.6 (out of a maximum of 7), at par with the global average (Figure 4). The digital divide in big data for tourism can be clearly seen, however, with Japan, New Zealand, the Republic of Korea, Singapore, and Hong Kong, China being the most ICT-ready economies in all of Asia. These economies have higher ICT readiness scores than the United States and the European Union. Other developing economies have an average score of 4.0. As illustrated with the examples of Indonesia and Thailand above, developing Asia has thus a high potential to embrace the possibility of big data.

Destinations at the lower end of ICT readiness consistently have less developed or nonexistent big data programs and rely heavily on big data vendors to support their efforts, the opposite of economies with higher ICT scores. However, subnational destinations within these economies most often do not have their own big data programs or the capacity to take advantage of existing domestic programs. Before even considering working with big data, therefore, a destination must prioritize raising overall ICT capability and closing its internal and external digital divide, as each of the subsequent challenges of working with big data are magnified or reduced in proportion to ICT readiness. That said, even destinations with low ICT readiness have a way forward, including purchasing big data reports and working with big data providers for partnerships.

Figure 4: Information and Communication Technology Readiness Scores of Selected Economies and Regions, 2019



Notes: The maximum information and communication technology readiness score is 7. The global average is 4.6. Developing Asia comprises Armenia; Azerbaijan; Bangladesh; Brunei Darussalam; Cambodia; Georgia; India; Indonesia; Kazakhstan; the Kyrgyz Republic; the Lao People's Democratic Republic; Malaysia; Mongolia; Nepal; Pakistan; the People's Republic of China; the Republic of Korea; Singapore; Sri Lanka; Tajikistan; Thailand; Viet Nam; and Hong Kong, China. Other developing economies comprise Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Chad, Democratic Republic of Congo, Cote d'Ivoire, Eswatini, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Tanzania, The Gambia, Uganda, Zambia, and Zimbabwe; in Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, and Venezuela; in the Middle East and North Africa: Algeria, Bahrain, Egypt, Islamic Republic of Iran, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, United Arab Emirates, and Yemen. The European Union comprises Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, and Sweden. **Source:** World Economic Forum (2019). Regional averages were computed by ADB using World Economic Forum 2019 data.

Reports analyzing big data in tourism can cost nonmembers \$400 for a small report, while larger flagship reports start at \$4,000. Marketing partnerships and tourism-focused big data consultants are the next most expensive tier of engagement, while building or buying tourism-focused big data is the most expensive tier. Moreover, tools to collect, store, and process the data, and obtaining a network of specialized computers to transfer it (Widjaya 2019) will raise costs, as will ongoing costs of storage, platform or software license subscriptions, data cleaning for migration, network bandwidth (Widjaya 2019), and salaries for a technical big data team and data privacy counsel. Moving huge amounts of data during a short period of time for migration and use of big data on a regular basis will need to be planned, as it could affect ongoing costs and capacity issues for company networks (Widjaya 2019).

B. Data Privacy

Data privacy is arguably the most important issue governments must take into account as they begin working with big data. This is not tourism specific. This is an era of changing and evolving data privacy laws in many domains. As stated in the World Economic Forum 2019 Global Competitiveness Report: “[Technology] governance

has not kept pace with innovation in most countries, including some of the largest and most innovative” (WEF 2019b). Even the two best-studied applications of big data for destination management and product—credit card transactions and mobile location data—involve high data privacy concerns. According to a study of 1.1 million anonymized credit card records in the United States, only four “spatio-temporal” points proved enough to uniquely reidentify 90% of individuals, while “coarsened” data (data made less granular) proved no more effective at protecting reidentification (de Montjoye et al. 2015).

Regionally, the Asia-Pacific Economic Cooperation (APEC) Privacy Framework, developed in the early 2000s and since updated, can provide a uniform standard for data protection laws across the region. The framework refers to personal information as any information about an identified or identifiable individual. It was “developed and updated in recognition of the importance of implementing appropriate privacy protections for personal information, particularly from the harmful consequences of intrusions and the misuse of personal information” (APEC 2015).

The APEC Privacy Framework is advisory only, not legally binding. This means APEC member economies may or may not voluntarily commit to following its suggestions (Raul 2020). Thus, APEC created the Cross Border Privacy Rules system in 2011 to establish “enforceable binding commitments” that “lift the overall standard of privacy protection throughout the region through these voluntary, yet enforceable, standards” (APEC 2019a; CBPRs n.d.). However, despite its robustness and nearly 10 years of existence, Cross Border Privacy Rules has only been fully adopted by nine destinations, seven considered developed and only one a developing economy in Asia.

This shows just how complicated it is to harmonize and get buy-in to cross-border data privacy laws, particularly since data privacy (like cybersecurity below) is a constantly moving target. Privacy is a legal and technical discipline as technically complex as the big data itself. As a result, destinations face significant costs not only to recruit and finance strong ICT candidates for their tourism-focused big data programs, but also to staff data privacy monitors.

Investments in data privacy must, however, be made and information collected communicated to all travel and tourism stakeholders, including and especially travelers. Doing so will not only ensure their continued digital safety but also safeguard the destination’s reputation. As tourism-focused big data programs continue their spread across the region, consumers will increasingly become aware of what information different destinations are tracking about them. If perceived as collecting too much data or being too invasive, or if a data breach takes place and is made public, destinations may suffer negative brand consequences, even if the technology and big data programs in place are productive and conforming to local regulation. Thus, individual destinations must work with multiple ministries with their own data protection policy leaders to protect individual privacy without stifling technical and business environments conducive to growth and innovation.

C. Cybersecurity

Cybersecurity is the practice of defending computers, servers, mobile devices, electronic systems, networks, and data from malicious attacks (Kaspersky 2017). In the first half of 2019 alone, data breaches exposed 4.1 million records, while the World Economic Forum's 2019 Global Risks Report lists "massive incidence of data fraud/theft" and "large-scale cyber-attacks" as the fourth and fifth, respectively, in the top-10 risks by likelihood of occurrence (Winder 2019; Myers and Whiting 2019).

Data breaches not only violate an individual's safety and rights, but are financially and reputationally expensive for data owners. A 2019 report by IBM found that data breach costs can impact organizations for years, with an average impact per breach per business of \$3.92 million globally and \$2.62 million in Asia (IBM Security 2019).

Both the tourism sector and regional government data programs have been subject to attacks. Marriott and Cathay Pacific discovered a large-scale data breach in 2018, and Singapore suffered notable cybersecurity attacks in 2018 and 2019. Thus even the biggest or most technologically advanced players in big data are vulnerable to cyberattacks, primarily because, like data privacy, cybersecurity is a constantly changing discipline that requires highly skilled ICT professionals to manage the system and keep it up to date, at considerable cost. Therefore, as tourism governments around the region gain access to big data by way of partnerships or create their own platforms for data aggregation and analytics, ensuring data security must remain a priority.

D. Skills Gap

Regional skill shortages and skill mismatches of ICT professionals are already being felt in all categories of expertise required (Table 4). According to the Closing the Digital Skills Gap survey, 75% of respondents—comprising employers, government officials, and academics—report a significant skills mismatch (APEC 2019b).

Furthermore, the International Information System Security Certification Consortium ((ISC)² 2020), a leading global association for cybersecurity professionals, reported a global gap of 3.1 million cybersecurity professionals in 2019, with a staggering 2.1 million of them in Asia and the Pacific. The Appendix lists the skills needed for big data compilation and analysis.

As a result, a highly competitive landscape has emerged in which governments are competing with private sector organizations domestically and globally to recruit and retain professionals from an increasingly tightening ICT talent pool relative to job vacancies and newly created ICT jobs. But governments cannot compete with private sector technology firms on salary and perks alone (Lee 2016), and ICT upskilling and retraining is not without its risks. Thailand recently established its Government Big Data Institute to train its first 1,000 government officers in big data skills in 2020.

The institute has one module explicitly about using big data for tourism modeling (DEPA n.d.). However, retention could prove difficult, as qualified candidates can expect a 25%–30% average salary increase when switching to the private sector (Sharon 2019). This difficulty will become more acute as Thailand 4.0 deepens and more private sector ICT roles come online.

Thus skills gaps, shortages, and competition pose a threat to tourism-focused big data programs in destinations of all types, but these programs may themselves have an adverse impact on jobs, as the drastic reduction in the number of enumerators in the case of Statistics Indonesia demonstrates. With other industries also moving to implement big data, enumerator livelihood could be at risk if new skills are not developed.

Table 4: Skills Required to Use Big Data

Non-ICT Skills	Legal and Institutional Skills	Statistics and ICT Skills	
Business analysis	Legal expertise	Official tourism statistics	Database management
Project management	Data privacy	Data science	Big data analysis and big data visualization
Domain expertise		Computer programming	Machine learning

ICT = information and communication technology.

Note: See the Appendix for descriptions of the skills required to use big data.

Source: Authors based on EU (2019).

E. Structural Dependency

Unlike traditional tourism statistics that rely mostly on in-house collection and processing, the majority of big data datasets and platforms useful to tourism are held by private companies, of which the most prominent are a limited group of mostly corporations in North America and the People's Republic of China (PRC). These are accessible mainly through commercial agreements and partnerships. Given their size and breadth, these early movers are driving the global regulatory environment for digital platforms. This not only gives them an unfair advantage over new market entrants, but also creates a “structural dependency” on their services for government and private sector business in travel and tourism (Fereidouni and Kawa 2019).

More broadly, as big data from private sources are streamlined into official statistics, governments may lose negotiating power to change suppliers. While in some cases there are multiple providers with complementary datasets (online travel agents or metasearch companies), the transaction costs of switching providers and the inherent schisms of data comparability between providers could reinforce the problems of structural dependency (Eurostat 2017).

F. Small and Medium-Sized Enterprises Inclusion

Micro, small, and medium-sized businesses account for 99% of all businesses in APEC, while providing 50% of employment in the tourism sector (APEC 2019c). Despite their size and importance they face considerable challenges region-wide in digitalizing their businesses. The *Southeast Asia Going Digital: Connecting SMEs*, an OECD (2019a) report on digital inclusion in the Association of Southeast Asian Nations, refers to the results of several studies confirming that only 16% of SMEs in Southeast Asia were truly digitized, with only 10% at an advanced level of adopting digital tools (i.e., customer relationship management, analytics, big data, automation, pure online business, scanners, bank card readers, central servers, imaging devices).

This is a real challenge for governments as they continue investing in big data programs. Ostensibly, the insights generated by government-level big data programs are to support their own better decision-making but also turn into tools, reports, and insights that can cascade down and empower the industry with their own strategic planning, if not their day-to-day operations. With only a small percentage of SMEs capable of using “advanced level” digital tools like big data, there is a risk that only larger players capable of learning from government big data programs and investing in their own big data programs can benefit from such a program. Other SMEs will be left further behind.

G. Lack of Governance and Policy Support

A lack of focused policy and incentives for the private sector continues to undermine progress of big data adoption. A comparative analysis of over 200 policy initiatives related to big data in 37 countries conducted by OECD (2019b) uncovered three key insights:

- More than 65% of policy initiatives still focus on public-sector data, the majority of these on open access to government data.
- Few countries have policy initiatives to facilitate data sharing within the private sector and between government and the private sector, even though sharing and reuse of data held by the private sector is the most frequently cited emerging challenge.
- Only 12% of all policy initiatives aim to increase data analytic capabilities in either the public or private sectors, despite the need for complementary investment in data-related skills and infrastructure.

In 2020, the United Nations Statistics Division (UNSD) conducted a global assessment of institutional readiness for the use of big data in official statistics, and similarly found that, “Legal frameworks are still insufficient to regulate big data applications. Only a small share of (national statistics offices) rely on legal frameworks that guarantee access to big data” (UNSD 2020).

The need is clear for private sector data sharing, as is the anxiety about it creates, yet investments in both new policies and skills to enable and harness it have failed to materialize. Further, developing new policies and frameworks are not the only barriers. Legacy policy also creates barriers to sharing big data. Laws to protect against market-moving are a good example. If a global distribution system, online travel agency, metasearch company, or any other type of big data provider that possesses deep and wide data coverage of destinations and brands of all kinds is not careful with the data or insights it provides in current or future performance of a certain destination, product type, brand, or booking trends, it can be seen as possessing “market-moving information” and in breach of finance law.

In recent years, several prominent destinations in the region have enacted data localization laws that provide greater cyber espionage and data privacy protections, minimize and facilitate easier investigation of cybercrime, and may have economic advantages, but also represent new barriers to data sharing. These laws impose mandatory legal or administrative requirement directly or indirectly, stipulating that data be stored or processed, exclusively or nonexclusively, within a specified jurisdiction (Svantesson 2020). Destinations such as India, Indonesia, the PRC, and Viet Nam have proposed substantive data localization laws, though the severity and breadth of proposed and adopted laws vary considerably among them. Legislation in most instances has been overturned or toned down, however, owing to industry lobbying and public pressure, because data localization may detract from the value of government incentives to big data firms for their collaboration.

H. Other Market-Driven Disincentives to Collaboration

Two overlooked but powerful disincentives are working against more open private sector data sharing, especially for the most comprehensive and, therefore, potentially most valuable big data for tourism. First, the digital platforms at the heart of tourism and online travel are fiercely competitive and few in number. Online search is dominated by essentially one company, and social media data and online travel platforms are held by a small number of global players (UNDP 2020).

Second, and more nuanced, private sector big data providers may already be benefiting from public sector openness in ways that make it harder to incentivize them to invest time and resources by offering them additional benefits beyond the business value they are already receiving.

Ride-hailing platforms provide a good example. They benefit from integrating publicly available open government big data, such as live traffic, outages, weather, events, etc. into their systems, leading to dynamic pricing, accurate demand forecasting, route optimization, and better customer experience and bottom line. Meanwhile, they generate an enormous volume of data on transportation, traffic flows, and demand for services by locals and tourists that would be useful to urban and tourism planning. However, they tightly control these data and do not share them with the public sector (Funes 2015). Policies are needed to encourage data reciprocity to justify the risks and costs inherent in sharing and to top up the benefits already received.

2. Limitations of Big Data for Tourism

A. Underlying Purpose of the Data

Fundamentally, the primary limitation and therefore complication of using some sets of big data for tourism is that, by and large, some of these data have not been collected for tourism measurement. Rather, as outlined in previous sections, other purposes for which data have been collected may overlap with or be strongly related to tourism activity and its measurement—but this is not the same as collecting data specifically for tourism measurement purposes. Thus, in using big data, it is important to assess its relevance for the tourism sector and consider to what extent big data can be cleaned up to align more closely with the issues and needs at hand. Statistical tools can be employed to make such a determination.

B. Selectivity Bias and Data Invisibles

Official statistics are usually created by way of a tightly controlled process based on accepted *probabilistic sampling methods* for a specific collection period (Beręsewicz et al. 2018). The process minimizes sampling bias and allows the odds of the response from different representative groups of the target population to be calculated (Buelens et al. 2014), raising confidence in data accuracy and the robustness of the findings.

Big data, on the other hand, is an *organic, non-probabilistic* data source, collectively assembled by society in real time with the odds of any member being selected for a sample left uncalculated. They are, therefore, not necessarily representative. Indeed, the “big” in big data is not synonymous with “all.” Big data often overlooks people from the most vulnerable populations, given their lack of a digital footprint, due to the present and expanding digital divide. Known as “data invisibles,” such people are disproportionately migrants, women, children, rural, and slum dwellers, frequently marginalized and overlooked within their own societies (Shuman and Paramita 2016). In Asia and the Pacific, where 68% of the labor population or 1.3 billion people are employed in the informal sector, data invisibility issues could prove acute (ILO 2018). As a result, big data contains selection biases that rigorously designed official statistics, focus groups, and surveys do not. While such biases do not preclude the use of big data in official statistics or in business decision-making, they do need to be explored and taken into account before big data is exploited.

As governments begin using big data to inform policy formulation and unlock value in the tourism sector, those not represented by the data should be identified and their contribution to and benefit from the tourism ecosystem assessed. Studies such as *An Overview of Methods for Treating Selectivity in Big Data Sources* provide a good introduction to selection issues in big data and a framework for dealing with it (Beręsewicz et al. 2018). However, more exploration from real case studies is needed before the universal application can be made across the board to all big data for tourism programs. Until then, surveys and census will still be needed to supplement the findings of big data when used in tourism (Eurostat 2017).

C. Data Continuity

Official statistics are reliable and trusted also because of the rigor and stability of data inputs used year after year. The processes may have evolved and changed (for example, the use of digital surveys as opposed to pen and paper), but the underlying conceptual framework has remained constant (Eurostat 2017). This continuity does not uniformly apply to big data. Indeed, introducing big data can disrupt the continuity of official data and make comparisons and tracking trends over time difficult. A case study included in a later section of the report about Indonesia using mobile positioning data for border crossings is a good case in point, as the difference in official numbers collected before and after using big data are so extreme that they are not comparable.

D. Managing the Limitation of Big Data in Tourism

Given these limitations, big data will not be replacing official statistical processes for the foreseeable future, nor should it. Rather, it will continue to play an auxiliary role, serving as a data source to official tourism statistics, just like surveys and administrative records and providing insights and trends that can prove essential to guide tourism planning and management. This would in principle lead to information that satisfies the quality standards of official statistics in line with the Fundamental Principles of Official Statistics and the requirements of users of official statistics, while retaining the benefits of big data sources such as temporality and spatial granulation (UNSD 2014).

3. Creating an Enabling Environment for Big Data Opportunities

Globally, governments and regional bodies are still in the early stages of figuring out coherent, replicable, and binding frameworks for enabling the public and private sectors to share big data and work together. However, the value gap—and added value—of both sectors opening their data and working together is clear. According to OECD (2019b), when the public sector opens its data, it can potentially raise the gross domestic product (GDP) of a destination by 0.3% to 1.5%. When both the public sector and private sectors open up their data, the impact is estimated to be anywhere from 1% to 2.5% of GDP.

Therefore, it is imperative to establish enabling environments that incentivize the private sector to work with the public on both commercial and noncommercial terms. However, establishing such “win-win” scenarios is much easier said than done. In reality, data usefulness and value exist on a spectrum of openness and datasets need not be fully open to be valuable.

Developing destinations that do not have the technical or skills infrastructure to manage fully open big data datasets can benefit from receiving comprehensive reports and insights derived from big data even if they do not have access to the underlying datasets. More developed destinations that may already be receiving reports and

insights by way of commercial or other such partnerships with big data providers may benefit most from being able to access and combine “fully open” datasets with the data they are already storing and using. Therefore, a critical distinction is needed between openness and access. As “openness” of big data is not synonymous with its value, new policies should focus on enabling access to big data at various levels of openness, rather than taking “fully open data” as the main policy goal.

A. Emergence of Data Philanthropy

Absent adequate, widespread policy for attracting and encouraging greater private sector participation in data sharing, data philanthropy has emerged as a mechanism for data sharing. Indeed, private sector organizations can derive tangible benefit from data philanthropy that complements their corporate social responsibility initiatives, including insights from the analysis of their data, fair market compensation for access to their data, tax incentives, strategic relationships with government decision-makers in their industry or in general, and reputational benefits by way of publicity (European Commission 2020).

Policies that aim to develop these types of incentives individually or collectively could certainly help greater adoption of data sharing by the private sector, but the question remains whether these policies are enough to overcome the legal and business barriers. Moreover, corporate philanthropy remains limited and diffused, and involves high transaction costs. It is extremely rare for raw datasets to be shared. Given privacy, security, and legal complexities, big data providers need to spend time and resources on aggregating and de-identifying data before sharing. Further, since transferring datasets involves greater openness than report sharing or analytics access, it is less likely that corporations will engage at these levels (UNDP 2020).

B. Public–Private Partnerships

Public–private partnerships (PPPs) are one compelling model for driving cross-sector data sharing: they are a powerful alternative to data philanthropy because they give more agency and bargaining power, not only to the recipients, but also to the public sector as initiators of such partnerships. This increases flexibility to align public needs with private sector business interests. However, before engaging the private sector, the public sector should establish a systematic data-sharing program within its own ranks. This can begin with national ministries establishing national and subnational data-sharing programs. The more robust the data, the greater the public sector’s bargaining power when engaging the private sector.

The example of ride-hailing companies, given the above, highlights how certain firms already benefiting from open government data may not have strong incentives to reciprocate sharing their own data. However, both Singapore's Tourism Board and Thailand's Tourism Authority have used PPP models to incentivize the ride-hailing leader, Grab, to share more data and resources. Although Grab will have to dedicate extensive financial, data, and people resources to the PPP, this will be outweighed by the support of the destination's highest tourism authority for Grab to spread its core products to new and underserved communities, resulting in significant financial, social, and reputational returns on its investment. The two examples highlight the need for governments seeking access to privately held big data to find powerful incentives that align with business requirements.

However, hearkening back to the previous discussion on structural dependency, it is still unclear what happens to government-backed tourism big data programs when such partnerships are not renewed and access to private sector big data and skilled workers is discontinued. This will require more travel-industry-specific research as more of these partnerships come online over the coming years and their results are known.

V

USING BIG DATA FOR RECOVERY AND REGIONAL COOPERATION IN TOURISM

Big data is useful in understanding and combating COVID-19. Using datasets collected from a range of public health and other domains, big data has been applied to support contact tracing and surveillance across a variety of sources. This is predicting community and individual risk of infection and patient treatment outcomes, monitoring patients as they enter hospitals, identifying promising drug candidates, and estimating real-time virus spread and forecasting spread (Matthews 2020). Big data is also being used to understand the impact of the pandemic socially and economically to inform policy decisions. For example, using mobile phone data from Google, the Bank of Japan determined that discretionary spending for households rebounded “faster and more vividly” in Japan than in other economies after the initial lockdown measures lifted in May 2020, which, in turn, informed the government’s subsequent stimulus decisions (Kihara 2020). Big data from all disciplines has a key role to play in response to and recovery from COVID-19 and in better regional cooperation.

1. Impact of COVID-19 on Digitalization

COVID-19 has accelerated pre-pandemic trends toward digitalization. Remote work, telehealth, online banking, cashless payments, entertainment streaming, and e-commerce have grown tremendously during the pandemic. While the day-to-day intensity of these changes may diminish in the post-pandemic world as social distancing and lockdown measures fade, experts believe that the pandemic has led to irreversible digital shifts, with lasting impact across all economic categories and business types.⁵

Big data providers whose core businesses focus on tourism have been impacted just as much as other sections of the travel and tourism supply chain. However, they are likely to emerge from the pandemic in a strong position, given their overall market share and centrality to tourism distribution. Indeed, a consistent strategy has already emerged of destinations engaging online travel agents to stimulate domestic tourism recovery by way of promotions and product development partnerships, while big data from non-tourism sources and smart sensors technology continue to measure and inform recovery efforts. On the other hand, market intelligence companies have seen their relevance increase by providing updated information on recovery trends and indicators along the various points of the value chain.

⁵ See e-Conomy SEA report, *At Full Velocity: Resilient and Racing Ahead*, by Google, Temasek, and Bain & Company (2020).

A. Travel and Tourism SMEs Adopt Digital Platforms

Despite the dramatic drop in international travel bookings and limited domestic recovery, digitalization is still surging in tourism businesses. Several economies in Asia and the Pacific have developed highly innovative solutions to exploit big data. The Singapore and Visa study, noted earlier, uncovered that contactless payments in the country grew 15% in the first quarter of 2020 alone. It also found that despite an increase in consumer spending online for a variety of services, local brands, whose revenues have dropped significantly due to the lack of foreign visitors, were only making an average of S\$2 per S\$100 online. Yet, demand was growing for services from international brands with stronger online presence during that time (STB and Visa 2020).

The message is clear: SMEs and local tourism constituents have to embrace digitalization to offset these deficits. In locations like Singapore and Macau, China where digital platforms are being used for voucher dispersal and redemption, the local hotels and micro, small, medium-sized enterprises that were not using cashless payments like WeChat Pay, Alipay, or GrabPay before the pandemic, have since had to adopt the platforms to take advantage of the voucher programs and promotion schemes for their businesses. To offset losses, many restaurants and vendors that primarily served tourists joined online food delivery platforms, such as GrabFood, for the first time in order to cater to local customers.

The same is true for online travel agency adoption. Online travel agency partnerships for tourism promotion represent a core recovery strategy that will likely persist and expand well into the post-pandemic era as heated competition to attract the small population of available travelers intensifies with the uneven reopening of borders. Tourism businesses previously not on these platforms will miss out on the enormous promotion budgets being spent by their governments if they do not join them.

2. Case Studies: Big Data Helps Tourism Sector Recover from COVID-19

➤ A. “Macao Ready Go!”

➤ Lead Agency: Macao Government Tourism Office

Background

Having suffered a 99.5% decrease in year-on-year arrivals in the second quarter of 2020, the Macao Government Tourism Office launched the “Macao Ready Go!” initiative to stimulate tourism (China Travel News 2020). The first wave of the initiative focused on locals and featured a range of tourism products with subsidized rates, accessible only through an e-coupon program. From there, the tourism office scaled up the program and cast its partnership net wide across complementary and competing

mainland People’s Republic of China (PRC) partners such as Tencent, UnionPay, and Alibaba, and included airline partner Air Macau (TTG Asia 2020). The focus on partnerships with such platforms comes from their proven success in promoting domestic travel in the PRC after initial lockdown measures eased (GGR Asia 2020).

Obtaining and using big data for tourism recovery

Macao Ready Go! is a fully integrated big data program for tourism. By using digital coupons, the tourism office is able to access highly insightful analytics and know, based on digital engagement and coupon redemption, which channel partners and products resulted in the highest interest and businesses that derived the most benefit from their efforts.

Tourism operators and online travel big data are not the only form of big data assisting recovery in Macau, China. Preceding the autumn 2020 Macao Ready Go! promotional push to multiple domestic and PRC source markets by way of blockchain, big data was already enabling the safe movement of over 17 million travelers between May and mid-October 2020.

Guangdong Province in the southern PRC and Macau, China have mutually recognized health code systems based on blockchain technology, allowing health authorities on both sides to verify in seconds whether travelers are in good health or have been in contact with any known [COVID-19] cases. This can be done without accessing personal data, thus complying with privacy regulations that prohibit direct exchange of such information (Feng 2020). This system and widespread testing have allowed travel between Guangdong and Macau, China to restart at scale.

➤ B. “SingapoRediscoverers”

➤ Lead Agency: Singapore Tourism Board

Background

During 2019, Singapore received 19.1 million international visitors, who spent \$24.6 billion. These figures were expected to rise to 20.0 million visitors and \$26.2 billion in 2020 (PATA 2020a), but have fallen far short of their estimates, indicating that COVID-19 has had a devastating real and projected impact on the country’s tourism sector.

In July 2020, Enterprise Singapore, Sentosa Development Corporation, and Singapore Tourism Board launched “SingapoRediscoverers,” the largest-ever domestic marketing campaign in the country to encourage locals to explore different sides of Singapore. The campaign partnered with local communities to help them discover hidden gems, curating precinct itineraries to create authentic experiences, and collaborating with hotels, tour operators, attractions, and precincts to develop quality experiences and attractive promotions (STB 2020a).

Obtaining and using big data for tourism recovery

The Singapore Tourism Board has been assertive in enlisting the use of digital platforms and big data from a variety of sources for the SingapoRediscovered campaign. In September 2020, it announced a 3-year partnership with Visa and a 7-month partnership with the leading online travel agency platform, Klook, for booking tourism experiences and activities. The Visa partnership focuses on joint research and analytics and marketing partnerships to “address the needs of Singapore’s SMEs in the tourism sector impacted by COVID-19” (STB 2020b). To kick off the partnership, Visa and STB jointly published a detailed report that included an overview of the hardest hit precincts, as per the drop in tourism retail activity, entailing a double-digit contraction in local businesses. The insights are fueling geographic and thematic product development for subsequent campaign pushes. Under the Klook agreement, joint work was focused on curated promotions for products and experiences, content development, and digital marketing to boost domestic spending (STB 2020c).

The Singapore government is also taking advantage of preexisting technology and big data infrastructure to roll out their recovery plan for the tourism sector. As a complement to the SingapoRediscovered campaign, an additional S\$320 million (\$238.4 million) in spending vouchers was distributed to incentivize locals to get out and support tourism (Min 2020). The tourism board appointed five big data and tourism partner platforms where vouchers can be redeemed, which furthers the big data loop tracking customer engagement from voucher downloads to voucher redemption (Sorrells 2020). Singaporeans and residents aged 18 years old and over who have a “Singapore Personal Access” or “SingPass” account will be able to log in and secure these coupons. SingPass is a digital platform that allows users to easily and securely transact with over 60 government agencies online. By using SingPass to distribute the vouchers, the tourism board can be in full control of the process. Deals can be targeted to precise segments and interactions with and adoption of every voucher type can be tracked, leading to better segmentation and product development for subsequent promotional phases.

Finally, for longer-term recovery, the tourism board signed a 3-year memorandum of understanding with online travel agency Trip.com to market Singapore as a destination of choice to four strategic source markets, including the PRC, the Republic of Korea, Thailand, and Hong Kong, China. Beyond promotions, the memorandum also focused on product development by way of combining insights from the big data collected by both entities (STB 2020d).

➤ C. Thailand's Partnership with Multiple Platforms

➤ Lead Agency: Tourism Authority of Thailand

Background

In 2019, tourism accounted for 15.9% of all employment in Thailand and 21.6% of GDP (PATA 2020b). As of September 2020, with tourism and other parts of the economy impacted by border closures, the overall Thai economy is projected to shrink a staggering 8% in 2020 (ADB 2020a). However, Thailand has been relatively successful in containing the COVID-19 virus as of mid-2021, with domestic case counts and fatalities among the lowest in the world. With the initial domestic lockdown lasting just a few months during 2020, the country progressively returned to a semblance of normal business, with a strong culture of social distancing and mask-wearing in place. With this progressive reopening, the tourism authority launched partnerships with various big data providers to drive domestic demand.

Obtaining and using big data for tourism recovery

Unlike Singapore and Macau, China which have robust underlying smart cities and other e-government infrastructure, destinations like Thailand need to focus heavily on online travel agencies and other big data partnerships to keep stimulating recovery, both domestic and international. Reflecting this requirement, in July 2020, the Tourism Authority partnered with the online travel agency Agoda for a multifaceted campaign to drive more domestic travelers to key destinations. The campaign was designed in part to help destinations struggling the most from border closures capture more domestic demand (Agoda 2018). Further, during August–December 2020, the Tourism Authority of Thailand launched partnerships with both Alipay and online travel agency, Fliggy, to exclusively target Chinese expatriates living in Thailand, incentivizing them to travel to key locations with exclusive deals and digital coupons worth CNY388 (\$60) available with each booking (TAT Newsroom 2020).

➤ D. The Republic of Korea's Travel Intelligence Platform

➤ Lead Agency: Korea Tourism Organization

Background

For the past 5 years, KT Corporation (KT) and the Korea Tourism Organization have partnered to revitalize the tourism sector (ADB and KT Corporation 2020). For example, KT developed Travel Intelligence Platform, which leverages the telco's mobile data and provides periodic tourism statistics and analysis of tourists' patterns in specific areas to inform and facilitate the Korea Tourism Organization's development of tourism strategies and policies.

Beyond the Travel Intelligence Platform, since 2019, KT has operated the first artificial intelligence-based big data platform to be shared and used by individuals and businesses on demographics, real estate, and consumption trends, among others (Lim 2019). Named KT Big Data Platform, it enables 113 terabytes of big data sharing between individuals and 16 relevant institutions in both public and private sectors covering credit card usage data, tourism data, delivery routes information, and illegal advertisement identification.

Obtaining and using big data for tourism recovery

The Travel Intelligence Platform provides tourism statistics and analysis using mobile and credit card data with geographic information system analysis of tourists' movements and detailed reports of tourist demographics, preferred attractions, and consumption patterns. The platform also collaborates with government tourism specialists to provide information about the tourism competitiveness of different sites, facilitate policy decision-making, and suggest marketing strategy.

KT obtains mobile data with long-term evolution signals that tracks people's movement generally and has developed methodologies to distinguish tourists among the masses. Every 5 minutes, the telco can estimate changes in population between base stations and mobiles, which allows it to capture accurate movement patterns. The long-term evolution signal data are generated regularly even when a mobile phone is not being used and are more accurate for analyzing tourists' movements, while generating 7,000% more data than call detail record. Further, domestic tourists' movements can be captured in base stations by applying statistical behavior of tourists, and short-term foreign tourists can be identified from KT's roaming data.

During COVID-19, the Travel Intelligence Platform has been used to determine the number of domestic visitors and analyze their expenditure patterns to help the government make better decisions for tourism recovery, considering limited public resources. Besides stimulus packages and discount programs, it is critical to have data that help provide an understanding of domestic tourists' demands, behaviors, and willingness to engage in tourism-related activities to design attractive products and boost recovery.

3. Role of Big Data in Post-COVID-19 Regional Cooperation

The resumption of large-scale international travel and uninhibited trade across the world and region will require an unprecedented level of regional cooperation in the adoption of new health and travel technology platforms that help facilitate sharing of sensitive health data. While the technology to enable this new paradigm exists and is being refined, underlying political, financial, and especially policy barriers undermine widespread adoption. Prominent regional bodies, including intergovernmental and nongovernment organizations, bilateral donors, and multilateral development banks with experience in driving regional cooperation have an important role to play as

conveners, funders, and harmonizers of regional efforts to alleviate the barriers to the adoption of the needed technologies.

A. Inflection Point for Seamless Travel

Pre COVID-19, advances were already being made in seamless travel. The Known Traveller Digital Identity program, a consortium partnership led by the World Economic Forum (KTDI n.d.), is a notable example. It completed the first-ever successful preliminary trial of “passport-less travel” in 2019.

Passport-less travel or “paper-free travel,” as defined by the program (KTDI n.d.) as follows:

[Based] on an interoperable digital identity, linked directly to government-issued identity documents (ePassports). It uses cryptography, distributed ledger technology and biometrics to ensure portability and to safeguard the privacy of personal data. The system’s security relies on a decentralized ledger platform that all partners can access. This ledger provides an accurate, tamper-proof record of each traveler’s identity data and authorized transactions.

By definition, seamless travel is an exercise in regional and international cooperation and PPPs. Even the Known Traveler Digital Identity pilot involved the governments of Canada and the Netherlands, Air Canada, KLM, Royal Dutch Airlines, Montreal-Trudeau International Airport, Toronto Pearson International Airport, and Amsterdam Airport Schiphol. Further, it was heavily supported by Accenture, Vision Box, and Idemia as pilot design and technology partners. Just for the testing of the pilot, all of these entities needed to agree on travel, entry, and exit policies, as well as a shared technology platform, among numerous other considerations. Despite international travel being mostly halted due to COVID-19, seamless travel initiatives like the Known Traveler Digital Identity are actually receiving enhanced attention as they are helping solve the emerging health and data privacy challenges of restarting travel.

B. Health Certificates and Blockchain-Enabled Travel

One key requirement to restart travel is to advance digital health certificates. It stores health information about a traveler that can be updated and read by authorized parties, such as official COVID-19 testing providers and border control and immigration offices. While there is not yet a widely accepted standard for digital health certificates, a few models with successful pilots are already under way in different destinations. For example, the blockchain model between Guangdong Province and Macau, China use the same blockchain system and medical coding for patient information. This has enabled the transference of tokenized COVID-19 testing information that can be read and verified on both sides, without requiring the actual transference of other sensitive patient data.

Even though the model is proven by the millions who have since traveled safely between the two destinations, it is nevertheless hard to scale. First, few destinations around the world have blockchain-enabled health-care systems already in place. Second, even if they did, a mutually intelligible coding system would need to be in place or developed between partner systems so that they could communicate in such a way.

To address the issue of scalability, new blockchain, tourism, and health big data models have emerged that build on the Known Traveller Digital Identity model and are showing great potential because they require less intensive infrastructure investments in that they hold interoperability as a core tenet.

One of the most compelling examples is the CommonPass framework. Created in collaboration between a nongovernment organization called the Commons Project, the World Economic Forum, and a broad coalition of public and private partners, CommonPass is trying to become the go-to globally interoperable platform for people to document their COVID-19 status related to health declarations, PCR tests, and vaccinations, to satisfy domestic entry requirements while protecting health data privacy. With successful pilots completed in October 2020 between the United Kingdom; the United States; Hong Kong, China; and Singapore, and with Airports Council International and the world's three major airline alliances joining the CommonTrust Network in November 2020, CommonPass has become a leader in the health passports (Commons Project Foundation 2020). Another innovative blockchain initiative is the travel pass developed by the International Air Transport Association (IATA), which also employs interoperability and decentralization to ensure seamless and safe data transference (IATA 2020). More recently a successful example is that of the European Union (EU) Digital COVID Certificate Regulation which entered into application on 1 July 2021. This allows EU citizens and residents to have their digital COVID certificates issued and verified across the EU and with some nonmembers such as Norway or Switzerland (EU 2021). The initiative is an example of political and technical coordination.

Although digital health certificates are gaining traction with airlines and governments, they are very much in the pilot phase (Russel and Parsons 2021). Whether they will be a success depends much on reopening of borders, the uptake of vaccines, active collaboration and coordination among governments, and global standardization for an integrated approach toward risk assessment and a secure and unified rollout.

C. Harmonizing Regional Health Data and Travel Technology

Despite the above advances in technology, the international transfer of health data in any form remains a complex and highly problematic policy and political issue. While it is beyond the scope of this report to discuss in detail, researchers have identified at least 20 potential barriers to cross-border health data sharing classified in six categories including technical, motivational, economic, political, legal, and ethical (van Panhuis et al. 2014).

This situation has worsened since international health and safety protocols for the travel industry proliferated in mid-2020, with complex, ever-changing, and often unclear information. To address these communication challenges, UNWTO and IATA have partnered to create a destination tracker providing information on air travel and health-related travel requirements at the destination (UNWTO 2021b).⁶

Virtually none of the existing systems recording this information are linked to each other, resulting in increased risk for miscommunication and mishandled health information, saying nothing of the traveler experience. Therefore, before the technology can be deployed, health and travel policies need to be harmonized across borders, while protocols will need to be harmonized between governments and businesses within destinations. The work of the International Civil Aviation Organization (ICAO) Council's Aviation Recovery Task Force (CART) provides practical, aligned guidance to governments and industry operators in order to restart the international air transport sector and recover from the impacts of COVID-19 on a coordinated global basis. The CART's work on its recovery report and the accompanying "Take-Off" guidance for international aviation, has kept the health, safety, and security of the traveling public of paramount concern throughout. The CART recommendations and guidelines will be continuously reviewed and updated based on the latest medical and operational advice, and are intended to harmonize and not replace the COVID-19 recovery road maps currently established by states, regions, or industry groups (ICAO 2021). By the same token, the International Organization for Standardization (ISO) has published ISO/PAS 5643, tourism and related services – requirements and guidelines to reduce the spread of COVID-19 in the tourism industry, which has a broad scope and will help all providers in the sector (accommodation, museums, transport, experiences, activities, and guides) to ensure safer services and prevent the spread of the virus (ISO 2021). It is designed to help tourism providers implement the best measures for everyone's safety and reassure tourists of the effectiveness of what they have in place.

The PAS has also been adopted by the European Committee for Standardization as the European Tourism COVID-19 Safety Seal, thus demonstrating its commitment to the guidelines and ensuring widespread take-up across the region (Naden 2021).

⁶ The UNWTO–IATA Destination Tracker (<https://www.unwto.org/unwto-iata-destination-tracker>) is the first global dashboard on air travel restrictions and health-related travel requirements at the destination. As the first one-stop-shop for global information on COVID-19-related travel regulations it aims to build confidence among travelers and businesses and support policy making by providing a global overview of travel restrictions worldwide. Available for free, it provides information and insights on the current status regarding air travel restrictions and measures in place at destinations worldwide.

4. Looking for Innovative Solutions and Advancing Regional Cooperation and Integration

Regional bodies and development institutions will be instrumental in facilitating post-COVID-19 regional cooperation. By leveraging their convening power of policy makers in different ministries across borders, such institutions will be able to identify and promote innovative solutions and best practices from around the world that inform regional decision-makers about the best actions to take. From there, technical assistance funds for policy and technological development can be disbursed to finance pilots.

For example, UNWTO launched its Healing Solutions for Tourism Challenge from March to May 2020 as a global call to reach the most disruptive startup entrepreneurs and to drive solutions to mitigate the impact of COVID-19 on tourism. The hackathon received over 1,000 applications, of which more than 113 came from Asia and the Pacific. Among those 113, five solutions made it to the final, with iBonus COVID19 Digital Prevention System from Hong Kong, China, picked as winner of the category of “Healing for Destinations.” The exercise was not merely a technology sourcing exercise. To support its member states and tourism stakeholders in identifying and mitigating global and local risks related to tourism, UNWTO—through its extensive networks and resources—was able to foster greater collaboration for selected finalists by adding them to a digital booklet disseminated to 150+ ministers. It thus afforded the finalists an opportunity to present their solutions to world governments.

ADB (n.d.a) has similarly run two programs focused on health and travel technology under its “#DigitalAgainstCOVID-19” Hackathon banner. The first was from April to July 2020, titled “Restoring Public Confidence on Safe Travels,” and the second from November 2020 to January 2021, titled “Re-Establishing Tourism Confidence through Innovative Digital Solutions” (ADB n.d.b). Like the UNWTO hackathon above, the goal is to leverage ADB’s convening power and resources to source and then expose leading technologies to governments around the region, such that recovery can be as coordinated as possible using the most robust technologies.

VI

BIG DATA FOR SUSTAINABLE TOURISM RECOVERY

The extraordinary financial pressure on the sector caused by the pandemic has created incentive for a rapid return to pre-pandemic tourism models. As is well documented, across Asia and the Pacific, tourism accounted for well over 10% of GDP in many economies, with some as high as 20% and a few exceeding 40% (ADB 2020b). At the same time, the impact of the lockdowns in many economies has led to growing demand for nature-based, rural, or open-air experiences, highlighting the need for speedy improvement in tourism infrastructure. Satisfying this demand is complicated by the time required to implement sustainable tourism infrastructure projects, such as wastewater treatment, waste management, and clean drinking water.

Many industry stakeholders see the crisis as a narrow window of opportunity to reset tourism and create a more sustainable and inclusive sector that prioritizes resource management and equal benefit distribution across the value chain. But, in a rush to restart economic activity, the intense and coordinated efforts required for a sustainable recovery may be left behind. Also, the enormous and rapidly growing Asian domestic market will arguably be choosing traditional mainstream travel options consistent with pre-pandemic travel for the foreseeable future. The greening of the Asia and Pacific tourism sector after COVID-19 is therefore far from a *fait accompli*. This prospect raises the question of how tourism destinations across the region can use big data to rebuild smartly and sustainably while catering to growing demand. The main steps in the use of big data in this context involve developing proper indicators to measure the impact of tourism and develop financial metrics to guide establishment of sustainable funding mechanisms for tourism recovery and development.

1. Toward New Measurement Frameworks

The need for expanding and enhancing tourism measurement frameworks to include not just the economic but also the social and environmental dimensions has become acute.

In response to this call and in line with the Sustainable Development Goals (SDGs), UNWTO launched the Towards a Statistical Framework for Measuring the Sustainability of Tourism initiative with the support of the UNSD. The initiative will supplement the guidelines issued by UNWTO in the 1990s on procedures to develop

destination-specific indicators and application types (e.g., coastal, urban, ecotourism, small communities) (UNWTO 2020b). The framework covers relevant topics such as management of natural resources (waste, water, energy, etc.), satisfaction of tourists and host communities, and preservation of cultural heritage (Table 5).

As depicted in Box 2, Measuring the Sustainability of Tourism will provide a statistical framework for economies to produce reliable, comparable, and integrated data to guide policy development and decision-making.⁷ The Measuring the Sustainability of Tourism framework is recognized by the UN Statistical Commission as the main tool to evaluate the contribution of tourism to the SDGs, and it aims to link the commission's System of Environmental-Economic Accounting with the tourism satellite account framework, one of two existing official frameworks for measuring tourism.⁸

The forthcoming global standard provides an organizing structure for the most relevant data and indicators and supports harmonized data production focused on international comparability. It emerges from the building of UN-backed international consensus on innovative statistical approaches, while recognizing the potential of big data as both a source of official statistics and as a complement to statistical information.

⁷ As of August 2020, 11 Measuring the Sustainability of Tourism pilot destinations—Austria, Canada, Fiji, Germany, Italy, Mexico, the Netherlands, the Philippines, Saudi Arabia, Sweden, and Thailand. In addition, Samoa and Viet Nam have undertaken projects to measure tourism sustainability using tools in line with the statistical framework for Measuring the Sustainability of Tourism.

⁸ The other existing framework is the International Recommendations for Tourism Statistics, which was adopted by the UN in 2008 with a strong recommendation that “linking tourism and sustainability be considered a priority.” Both official frameworks remain valid.

Table 5: Examples of Key Statistical Data and Indicators on the Social, Environmental, and Economic Impacts of Tourism at National and/or Subnational Levels

Economic	Environmental	Social
Tourism industry value added	Water use in tourism industries (including wastewater flows)	Culture and/or heritage
Tourism nominal GDP	Energy use in tourism industries	Health outcomes
Tourism establishments	Greenhouse gas emissions generated by tourism industries	Education
Tourism expenditure	Solid waste generated in tourism industries	Community
Tourism infrastructure assets	Land use (including marine areas)	Visitor perception
Employment in tourism	Ecosystem condition and services for tourism-related areas	Tourism governance
Demographics of tourism establishments	Wildlife in protected areas and/or parks	Accessibility
Investment and infrastructure	Green jobs	Decent work

GDP = gross domestic product.

Source: UNWTO (2020b).

Measuring the Sustainability of Tourism is expected to provide integrated information to better manage the currently unmeasured externalities caused by tourism, facilitate cross-sector dialogue on sustainable tourism development, and encourage coordinated locally relevant decision-making (Table 6).

Table 6: Operational Externalities—Cost per Tourist

Currently Accounted For	Typically Unaccounted For
Airports	Greenhouse gas emissions
Transportation networks	Maintenance of natural ecosystem
Communication networks	Restoration of ecosystem services
Nonrenewable energy sources	Renewable energy costs
Nonrenewable water sources	Renewable water sources
Wastewater management (in developed world)	Wastewater management (in emerging economies)
	Sociocultural restoration
	Sociocultural maintenance

Source: Epler Wood, Milstein, and Ahamed-Broadhurst (2019).

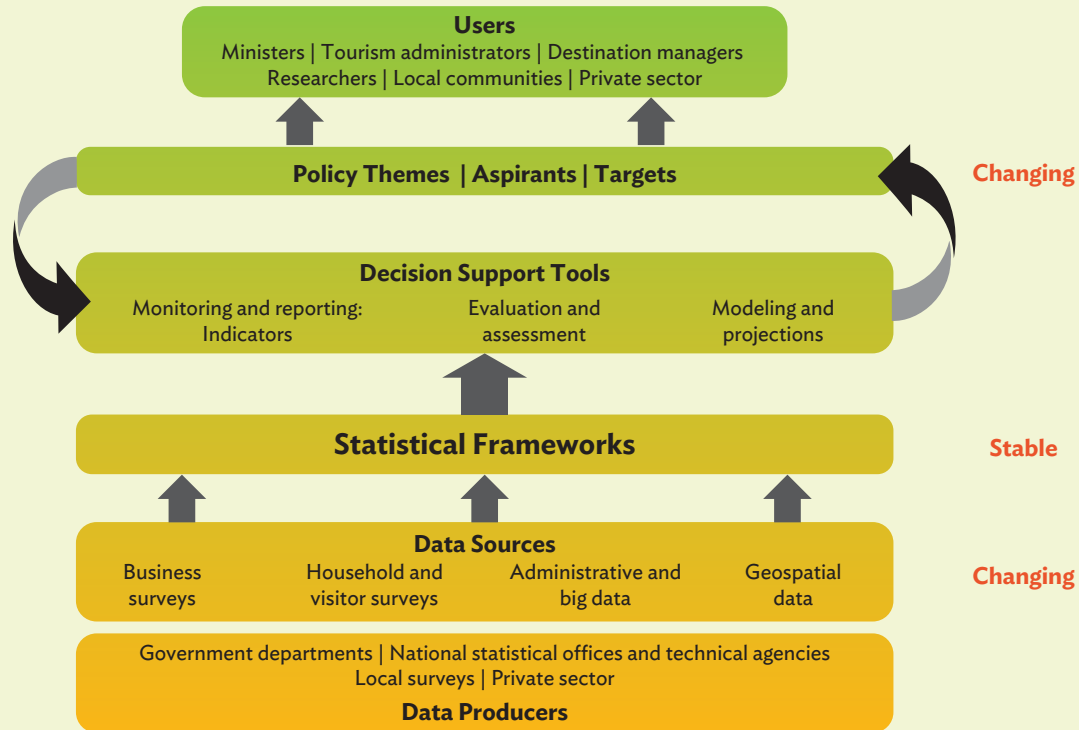
2. Financing Needs of Post-COVID-19 Sustainable Recovery

Early and compelling models have emerged during the pandemic that retain the centrality of digitalization and big data in tourism regeneration through and beyond the COVID-19 crisis. They suggest that financial metrics developed using big data be used to guide the establishment of sustainable financing for the development of

Box 2: Statistical Frameworks Link Data Sources to Data Use

A statistical framework is an organizing structure for data and statistics that provides a common understanding of concepts, definitions, and related terminology. A framework is independent of the sources from which data might be collected and from the methods used to compile the statistics.

The role of statistical frameworks is depicted in the figure below, where multiple data sources, covering economic, social, and environmental datasets, among others, are brought together through statistical frameworks to provide a coherent set of information. This can support (i) monitoring and reporting (and associated indicators), (ii) evaluation and assessment, and (iii) modeling and projections. Each activity is an important part of policy and decision-making.



Source: UNWTO (2018c).

Over time, the importance of statistical frameworks becomes more apparent, since while the concepts and definitions can be kept relatively stable, it is likely that (i) data sources will change over time—such as the emergence of big data and spatially rich datasets—and (ii) policy themes, aspirations, and targets will continue to change. Maintaining a stable statistical framework at the heart of measurement ensures that data can be meaningfully linked to policy and that ongoing, effective comparisons can be made even as data sources and policy needs change.

The challenge in developing the Measuring the Sustainability of Tourism statistical framework is to align the economic, environmental, and social dimensions of sustainable tourism statistics, which is currently largely missing. Overcoming this fragmentation, while focusing on the most relevant issues for sustainable tourism, is the key objective of Statistical Framework for Measuring the Sustainability of Tourism.

Ultimately, data should be collected and analyzed consistently over time and across different destinations and economies. Implementation of a statistical approach allows for this by developing standard definitions and concepts, non-overlapping measurement boundaries, and clear means of comparing and integrating different components.

Source: UNWTO (2018c).

the sector. One example is from Constantin and Yu (2020), titled *Reimagining the \$9 Trillion Tourism Economy—What Will It Take?*, which gives the following four ways that governments can evolve their role in the tourism sector as a result of the crisis:

1. Streamlining public–private interfaces through a tourism nerve center
2. Experimenting with new financing mechanisms, including revenue-pooling structures for hotels and joint equity funds for small and medium-sized enterprises
3. Ensuring transparent, consistent communication on protocols
4. Enabling a digital and analytics transformation within the tourism sector

A Marshall Plan for Tourism: Can It Be Built? explains that at the center of this destination-based recovery model is a data-driven finance system guided by “environmental, social and financial metrics to guide investments into the improvement of local economies” (Epler Wood 2020). These Sustainable Tourism Investment Hubs would be guided by “Centers for Destination Information and Technology,” which would become an operating body for using multiple data streams, including big data, to complement official statistics and fuel sustainable decision-making at the destination level.

The hubs would have a Sustainable Tourism SME Fund and a Sustainable Infrastructure Fund. Funding components could come from international development and climate-related finance sources, as well as potentially private family funds and private equity. This model goes further than others by including a capacity building and technical assistance facility as the fourth part of the destination hub to ensure destination managers have the requisite skills to deal with digitalization and big data. It seeks to provide technical assistance and capacity development to destination management organizations, local governments, and SMEs to prioritize sustainability and manage critical data during recovery.

Again, it cannot be overstated: the central axis of both the McKinsey “Nerve Centre” and Marshall Plan “Sustainable Tourism Investment Hubs” models requires a strong policy-led prioritization focused on investing in not only the data itself, but the skills and partnerships required to implement the data within established global frameworks for its use. Only then will the opportunity to use big data to create a more resilient, sustainable tourism industry be possible, in short, to achieve the vision of “building back better.”

Under the new Investment Readiness for Green Finance Mechanisms initiative, UNWTO has also been working alongside the International Finance Corporation, which is a member of the World Bank Group and the largest global development institution focused exclusively on the private sector in developing economies, on a series of training programs. One of the main foci of the new initiative is working with private sector partners to promote green finance and share experience in resourcing sustainable buildings. The initial cooperation consisted of a series of trainings to promote green investments for the long-term recovery of the tourism sector (UNWTO n.d.d).



CONCLUSION AND POLICY RECOMMENDATIONS

The insights drawn from the compilation and analysis of big data can help the tourism sector recover from the devastating impact of the COVID-19 pandemic and set the stage for the sustainable recovery and development of the sector. However, for most destinations globally, especially developing destinations in Asia, adopting big data for strategic planning and management faces many challenges, including financial, governance, skills, and other capacity gaps. Addressing these challenges and ensuring that the tourism sector creates a net benefit for destinations, locals, and tourists requires (i) prioritizing investments in big data systems to remove these shortcomings, (ii) partnering with private and public sector big data providers, (iii) adopting proven measurement systems based on international standards for sustainable tourism planning and management, and (iv) cooperating across the region on tourism-related policies.

The COVID-19 pandemic accelerated digitalization and the adoption of big data for tourism by businesses and governments. The use of big data in particular has become even more relevant, given the uncertainty and volatility of this crisis and the need to have updated information on tourism and related issues as well as to promote seamless travel solutions.

This development offers unique and unprecedented opportunities to use big data for the sustainable development of tourism. However, the health and economic toll of the pandemic has also created strong incentives to return to business as usual, to the detriment of long-term strategic investments in big data that would allow better measurement, planning, and management of sustainable tourism. Therefore, if—and it remains an *if*—the sector is to truly rebuild smartly post-pandemic, thoughtful policy interventions will be needed that correctly harness the positive momentum of digitalization and the potential of big data while addressing the extreme near-term challenges of business continuity facing the trade.

Policy Recommendations:

1. *Prioritizing sustainability and establishing big data policies and programs*

- Take a strong stance on sustainability by investing in the development and deployment of measurement systems based on international standards. For example, the Measuring the Sustainability of Tourism initiative can track metrics that show the economic, social, and environmental impacts of tourism, accounting for indicators such as local satisfaction, gender equality, carbon emissions, water usage, and waste management

- As a priority for tourism recovery, enhance digitalization by investing in the development of big data programs to improve destination measurement, planning, and management.
- Invest in the development and deployment of frameworks based on international standards for using big data as complementary sources to official tourism statistics.
- Develop institutional frameworks and incentive schemes for private sector sharing of big data that address issues of access and data continuity at different stages of data openness.
- Work with multiple ministries and complementary agencies such as urban planning, waste, energy, and safety to share the resources and data required to build and manage “smart destinations.”
- Better integrate national tourism organizations and destination management organizations with local governments in a “whole government approach” to position and leverage the tourism sector as a promoter and executor of smart destinations and big data development, not solely as a beneficiary.
- Establish local platforms that coordinate new data streams for targeted decision-making by tourism authorities, public and private investments, capacity development, and the design and deployment of new finance mechanisms for the sector.

2. *Funding and capacity development for big data*

- Allocate a budget for establishing a big data team, with a supervisor reporting to the national tourism or destination management organization head.
- Audit and assess data needs and available sources as well as existing and required technical, human, and financial resources.
- Build capacity of national tourism and destination management organization employees in big data analysis to support statistical and complementary data production.
- Train national tourism and destination management organization employees to combine new measurement systems and data with existing tourism indicators for more holistic decision-making.
- Invest in core information and communication technology (ICT) and big data skills capacity development for tourism employees at national and subnational government levels, including statistical analysis, computer programming, data science, data privacy, and data security, while also bolstering incentives (salary, further education opportunities, pensions) to keep these employees in the public sector.
- Systemize incentives for successful local and international ICT and big data talent from the private sector to work for or on government-led tourism projects.
- Address the unfolding dire skills shortages for essential ICT and big data positions by subsidizing university-level study of key skills with required government service upon completion at varying lengths for different levels of study (bachelor’s, master’s, and doctorate degree) and disciplines (data privacy, data security, data science, and the like).
- Create partnerships with local and international academia to gain skills and technical support needed for working with big data in tourism.

3. COVID-19 recovery: Policies and public-private partnerships

- Establish or ensure tourism's representation on multi-ministerial task forces composed of health, travel, transportation, immigration, and data privacy and security officials specifically charged with finding solutions to harmonize existing policies about health data with emerging big data and blockchain technologies that enable safe reopening of borders, regionally and globally.
- Fast-track adoption of legal frameworks that allow sharing of public-sector big data domestically and internationally across all domains to help post-COVID-19 recovery, while coordinating and encouraging the domestic private sector to do the same.
- Design policies to encourage data reciprocity to compensate for the risks and costs inherent in sharing.
- Harmonize health and travel policies and protocols across governments and the businesses within destinations.
- Work with multiple ministries with data protection policy leaders to protect individual privacy without stifling technical and business environments conducive to growth and innovation.
- Establish public-private partnerships (PPPs) with big data providers that leverage the private sector's near-term recovery needs with incentives tied to the long-term sustainable redevelopment of destinations, as measured in accordance with international standards and good practices to be credible and comparable.
- Continue advocating the value of big data for tourism investments during border closures and other lockdowns by investing in PPPs with big data providers and proactively protecting marketing budgets.

APPENDIX

SKILLS REQUIRED FOR BIG DATA COLLECTION AND ANALYSIS

Working with big data in tourism requires a range of technical information and communication technology (ICT) and non-ICT skills. Certain non-ICT skills discussed below may be enough to get started, as big data providers can supply the technical ICT and consulting skills needed to apply the data to relevant business problems. Nevertheless, as their experience of this first phase of using big data for tourism deepens, and once government tourism organizations begin collecting, processing, and analyzing big data on their own to complement official figures, they will need to have the robust technical skills in place, which includes both ICT and statistical skills for dealing with big data.

1. Non-ICT Skills Required for Using Big Data

A range of non-ICT skills listed below can enable national tourism organizations and destination management organizations to work well with big data.

Business analysis skill is the most important non-ICT skill needed to take advantage of big data. It takes skilled business people to understand the big data problems requiring solution and apply their own or vendors' solution, before ultimately applying the insights to business planning.

Project management (non-ICT) is required when working with big data. As big data can be cross-cutting within national tourist organizations or destination management organization, and given the cost of running such programs, skilled project managers are needed to make sure the internal teams and external vendors are working in a timely way toward agreed-upon goals. Unfortunately, this is often overlooked. The need for skilled project managers grows in proportion to the size of big data projects underway.

Domain expertise is also required to harness the potential of big data. Unless high costs are borne to embed external consultants within the government agencies themselves, national tourism organizations and destination management organizations will not simply be able to “pay and walk away” when working with big data providers. Internal teams will need to understand what the big data providers are uncovering and then be able to translate the findings into action. For example, most early-stage projects involving big data will be for marketing. Thus, both **market research** and **digital marketing skills** are important domains of expertise

to work with such vendors. Similarly, if big data is being used to understand aggregate data from sensors on water usage during peak travel season, civil engineers and other water experts will be required to share baseline information, interpret the results, and design interventions that take into account the new data.

2. Legal and Institutional Skills Required for Using Big Data

Legal expertise across data privacy and cybersecurity must be considered before setting up any big data program. Individual team members, departments, or hired counsel must be on hand who have extensive knowledge of local, national, regional, and global data privacy laws and regulations. As discussed in the Challenges section, failure to consider data privacy and security from the outset can waste considerable time and financial resources when setting up new big data programs.

As such, **data privacy** legal experts are essential to have on board from the earliest stages of project conception. These individuals may be lawyers or very senior technical experts or policy leaders. They need not be full-time national tourist organizations or destination management organization staff as they may be consulted with from other branches of government. Such individuals will ensure vigilance with programs that the data collection, storage, and processing remains consistent with local legal regulations and technical best practices.

3. Statistics and ICT Technical Skills Required for Using Big Data

To move beyond simple big data exercises with a vendor/customer relationship, national tourism organizations and destination management organizations will need to create robust internal capacity for collecting and managing big data for tourism. While the precise composition of a data team will vary based on the business outcomes sought, new staff and new teams will need to be hired and designed under the direction of competent chief statisticians, chief technology officers, and lead data scientists with a wide range of skills that include (but are not limited to) official tourism statistics, computer programming, database management using structured query language (SQL) and nonSQL, big data analysis and visualization, and artificial intelligence (AI) and machine learning.

Official tourism statistics refer to the knowledge and skill set of applying accepted methodological frameworks for measuring and analyzing tourism. As big data is increasingly adopted beyond marketing and promotions to complement official tourism statistics, skilled statisticians with detailed knowledge of the limitations of big data will be needed to uncover points of divergence and synergy between what big data says versus data collected by other methods. Further, as globally accepted frameworks for using big data for official statistics in tourism and beyond, continue to emerge, official statisticians need to be given ample exposure and opportunities to learn these new models.

Data science refers to an overlapping skill set that combines multiple fields including statistics, scientific methods, and data analysis to extract value from data (Oracle n.d.). Those who practice data science, called data scientists, have a range of skills to analyze data collected from the web, smartphones, customers, sensors, and other sources. Lead data scientists, therefore, possess the skills and knowledge to lead the overall strategic direction of the national tourist organizations or destination management organization's big data program (Botelho, Laskowski, and Fitzgibbons 2019). They will have a demonstrated history of working with big data and complex technology, with a deep understanding of computer science, customer behavior, database management, and data architecture. Especially at the beginning of setting up a robust big data program for tourism, it is critical that national tourism organizations and destination management organizations recruit a lead data scientist who can then hire teams and managing contractors to build the new programs. The key function of the data scientist is to work with senior leadership to create a data strategy in line with the key business outcomes needed by the organization and then translate the strategy into executable actions. Depending on the organization, the lead data scientist should report to either the most senior tourism statistics officer, chief technology officer, or chief executive officer.

Computer programming refers to the skill of using one of many development languages to create executable computer programs. While numerous programming languages exist, key programming languages for big data include Python, R, Java, Julia, Scala, MATLAB, and Tensorflow (Babu 2019).

Database management allows a person to organize, store, and retrieve data from a computer (Knight 2018). As big data must be collected and organized in order to become useful, database management is a foundational skill required when working with big data. The most common languages needed for database management are SQL and nonSQL.

Big data analysis and **big data visualization** are the two skills needed to actually interpret the big data being collected. Big data analysts and visualizers have overlapping skills with other skill sets (such as SQL fluency, database experience, etc.), but their core function is different. While the core computer programmers may write the software to collect and sort the data and the database managers find optimal ways to store and retrieve the data, it is the analysts and visualizers who interpret the data to uncover the trends and then make them understandable to decision-makers. They are the ones who “unlock” the potential of big data for business impact. The World Tourism Organization (UNWTO) Tourism Dashboard is a powerful example of how useful visualizations of tourism data can lead to practical business insights (UNWTO n.d.c).

Machine learning is an advanced field of data science and AI. It refers to the process of designing computer programs to allow them to learn and optimize processes for desired outcomes in ways that humans do not already know (eduCBA n.d.). Machine learning requires the use of sophisticated algorithms to analyze increasingly

large and complex datasets without sacrificing accuracy. As big data systems in tourism grow, skillful machine learning and advanced AI will need to be deployed to handle and process the ever-increasing number and size of datasets being combined. Finally, machine learning and AI are increasingly being used to learn how to analyze complex unstructured datasets better. As these approaches mature and become more mainstream, they could assist with driving down the costs of dealing with big data in general, especially for smaller players.

Source: Authors based on European Union (2019).

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Big data is already being used to measure, monitor, and manage tourism development, but its potential remains to be fully exploited. This report discusses the trends, opportunities, and challenges in using big data and digitalization in the tourism sector. It highlights how big data is being leveraged for COVID-19 recovery and examines its relationship with statistical frameworks to better measure the economic, social, and environmental impact of tourism. Case studies of partnerships in Asia and the Pacific between the public and private sector demonstrate ways to tap big data.

About the Asian Development Bank

ADB is committed to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific, while sustaining its efforts to eradicate extreme poverty. Established in 1966, it is owned by 68 members—49 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

About the World Tourism Organization

The World Tourism Organization (UNWTO), a United Nations specialized agency, is the leading international organization with the decisive and central role in promoting the development of responsible, sustainable, and universally accessible tourism. It serves as a global forum for tourism policy issues and a practical source of tourism know-how. Its membership includes 159 countries, 6 territories, 2 permanent observers, and over 500 affiliate members.

