Journal of Hospitality, Leisure, Sport & Tourism Education xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of Hospitality, Leisure, Sport & Tourism Education

journal homepage: www.elsevier.com/locate/jhlste

Industry 4.0 technologies in tourism education: Nurturing students to think with technology

Eleonora Bilotta [a], Francesca Bertacchini [b], Lorella Gabriele [a,*], Simona Giglio [a], Pietro Salvatore Pantano [a], Tullio Romita [c]

[a] Physics Department, University of Calabria, 87036, Arcavacata di Rende, Cosenza, Italy
[b] Department of Mechanical Engineering, Energy and Management, University of Calabria, 87036, Arcavacata di Rende, Cosenza, Italy
[c] Department of Business and Legal Sciences, University of Calabria, 87036, Arcavacata di Rende, Cosenza, Italy

ARTICLE INFO

Keywords:
Industry 4.0 technologies
Innovative skills for tourism professionals
Tourism 4.0 curriculum
Tourism research application
Paper type
Research paper

ABSTRACT

The Industry 4.0 revolution is bringing major transformations in the tourism systems design suitable for technologically oriented consumers. Indeed, methods and technologies introduced by Big Data, Automation, Virtual and augmented reality, Robotics and ICT well fit with the Tourism 4.0 paradigm. However, tourism students are not yet trained on techniques, issues and methods related to the Industry 4.0 framework.

Hence, relying on a careful examination of the literature on tourism market trends linked to the offer of innovative technological services, we identified conceptual, methodological, technological and practical skills to be developed in an academic curriculum for Tourism Science students. Learning path were focused on: i) processes of data acquisition from social media, ii) data analysis using Machine Learning techniques and iii) data design into significant elements useful to implement communication systems in the tourism field.

Results: showed that the most of participants achieved a medium-high evaluation for the implementation of the communication systems, applying appropriately techniques and tools learned along the course. Furthermore, the high percentage of students satisfaction registered in relation to the course, revealed that students enjoyed this experience. Outcomes reflects the acquisition and the awareness of those skills that will enable students to be conscious protagonists of their role in tourism 4.0.

1. Introduction

The evolution of Information and Communication Technologies (ICT) and its integration in the manufacturing sector is changing the traditional industries, transforming the way in which goods are produced, developed and consumed, thus stimulating the development of new business models, services and behaviour in tourism field. Digitalization, automation, and human-like cognitive technologies are transforming the world we live in. The framework of the fourth industrial revolution, commonly called Industry 4.0 (I4.0), is growing at an impressive rate, producing unprecedented industrial scenarios in all over the world (Popkova, Ragulina, Bogoviz, 2019). First mentioned in 2011 at the Hannover International Fair (Kagermann, Lukas, & Wahlster, 2011; Pfeiffer, 2015), the

* Corresponding author.
E-mail addresses: eleonora.bilotta@unical.it (E. Bilotta), francesca.bertacchini@unical.it (F. Bertacchini), lorella.gabriele@unical.it (L. Gabriele), simona.giglio@unical.it (S. Giglio), pietro.pantano@unical.it (P.S. Pantano), tullio.romita@unical.it (T. Romita).

https://doi.org/10.1016/j.jhlste.2020.100275
Received 11 May 2020; Received in revised form 24 September 2020; Accepted 30 September 2020

term I4.0 identifies the use of Cyber Physical Systems (CPS) for production. In particular, the main objective is to optimize value chains through the implementation of controlled and dynamic autonomous production. Nine industrial pillars characterize I4.0: Internet of Things, Big Data and Analytics, Cloud, Simulation, Additive Production, Augmented Reality, Autonomous Systems, IT Security and Horizontal and Vertical System Integration.

Optimization of resource efficiency, eco-sustainability of the production systems, development of "smart factories" and possibility of customization of products and services are only some aspects that will improve, due to I4.0 technologies.

Furthermore, I4.0 allows new forms of interaction between humans, machines and software systems the so called Industrial Internet of Things, Services and People - IoTSP - (Bertacchini, Bilotta, & Pantano, 2017)(ABB, 2016). Recently, a lively debate concerns how CPS will change the work in the coming years (Dregger, Niehaus, Ittermann, Hirsch-Kreinsen, & ten Hompel, 2018). The integration will have effects on the planning, execution and maintenance of the working activity, considering the man at the centre of the system (Rauch, Linder & Dallasega, 2019), thus allowing workers self-development (Kaasinen et al., 2020). Consequently, it will be necessary to re-define "the requirements for Education and Qualification of People in I4.0" (Benešová & Tupa, 2017).

In the opinion of Sony and Naik (2019), the key elements to evaluate if an organization is ready to use I4.0 are as follows: the organization strategy, the level of digitization of the organization, extent of digitization of supply chain, smart products and services, employee adaptability with I4.0, top management involvement and commitment. In this scenario, disparities will become increasingly evident, for people, products, industries and training systems and the lack of work will grow, due to the automation and the use of industrial robots. Given this technological revolution, the challenge tourism industry must face concerns how to train new generations of professionals in the use of Industry 4.0 technologies. Tourism industry can have substantial benefits from the application of the I4.0 technological pillars (Ivanov & Webster, 2017, pp. 13–14; Rüßmann et al., 2015). However, the easiness with which approaches, methods and tools that Industry 4.0 allows to apply are strictly linked to Research & Development (R&D) strategies, implemented by Companies.

It follows that the tourism field increasingly needs to take into account the final skills of its employees in order to keep pace with the technological services currently in demand and available on the market. In order to prove that this can be done, we have carried out a teaching experimentation with the aim of providing knowledge, skills and tools on some of the key technologies of the I4.0, working with university students that attended the course of Tourism Science at the University of Calabria. In this way, it has been possible to think how to reformulate some tourism employees activities, with specific functions and skills related to consumer behaviour analysis. Hence, we introduced this changes in the academic course of General Psychology for Tourism students. The article is organized as follows. After the introduction, section 2 presents the reviewed literature, together with the analytical framework of this paper. Section 3 describes the adopted methodology, detailing the course contents, the method used to evaluate the final project and the student satisfaction questionnaire. Section 4 outlines results, discussing them in section 5 within some conclusions. Section 6 concludes the paper, highlighting limitations and further work.

2. Literature review

2.1. Challenges for the tourism field

The actual processing of Big Data into useful information is the key to sustainable innovation within Industry 4.0. Many researches discuss the technical aspects of Industry 4.0, but they do not pay attention to managerial approaches and organizational culture that can significantly affect many aspects of the working experience, thus influencing the successful implementation of this model in industrial settings. In today's competitive business environment, companies are facing challenges in dealing with big data issues for improving productivity (Bradlow, Gangwar, Kopalle, & Voleti, 2017) due to the lack of smart analytic tools. This inadequacy and lack of skills could cause a negative return of investments, since right knowledge and competences of a good management and analysis is useful to advance business performance when it is lacking. However, the real problem is how to integrate human resources in this scenario. Therefore, companies need to better understand the tourism market in which managers can use technologies as tools useful to creating new opportunities for providers and consumers (Pantano, Giglio, & Dennis, 2018). Thus, the educational experimentation presented in this article is mostly focused on understanding how organisations, especially training centres should spread out the Industry 4.0 culture, thus contributing to develop exact skills, through dedicated university courses. The competencies required are related to the innovation and concerned with both technical (new automated and complex technologies) and social aspects – communication skills (Krugh & Mears, 2018) also in tourism field. Tourism operators need to take a proactive approach with consumers and their needs, improving communication and cooperation skills to satisfy customers and promote *smart tourism* (Jovicic, 2019). From the above, it follows that the creation of partnerships between Academies and Companies could be fundamental to foster the improvement of methodological and technical skills of employees in the tourism industry, providing also technological and innovative knowledge (Chen, Chiang, & Storey, 2012). While the Industry 4.0 framework expands the space of the curriculum in Tourism Sciences, it is not clear which of these key technologies can be immediately exploitable by students. The research questions we considered are the following:

[1] What are the benefits of applying Industry 4.0 technologies in the field of tourism?
[2] What are the crucial and necessary knowledge and skills to create a successful curriculum for students at the end of a Course Degree in Tourism Science?
[3] What conceptual skills do students need to have?
[4] What technological skills do students require?

Table 1
Key educational topics related to I4.0 to provide STUDENTS. IT SHOWS HOW industry 4.0 technologies can be used to improve the tourism field.

INDUSTRY 4.0 TECHNOLOGIES	APPLICATIONS IN THE TOURISM AND HOSPITALITY FIELD
Virtual Reality (VR) together with **Augmented Reality (AR)** create computer-generated 3D environments passing through a continuum between the physical reality and a completely simulated environment.	**VR** replaces the physical world (Bertacchini et al., 2012), allowing the customer to enter in another world, while **AR** allows to tourism operators to provide their customers with functions with the following functions: a. Direct, real-time new experiences of the real physical environments that the hotels offer, changing their perception of the surroundings, thus increasing the customer's satisfaction, proposing Augmented Hotel Environments. b. Make information available to guests before and after their arrival, thus providing them with Interactive Hotel Rooms. c. Allow guests to open and close their rooms via beacon technology. d. Capturing technologically advanced customers, especially millennials, by using e-marketing and AR (Shabani, Munir, & Hassan, 2019).
Internet of things (IoT) refers to a set of technologies (such as distributed sensors in the environment and connected among them) that allow any type of device or system to be connected to Internet with the purpose to collect, monitor, control and transfer information to the end customers. IoT allows to collect individual, social and public data (Wise & Heidari, 2019, pp. 21–29).	Applied in the Tourism sector, especially to enhance travel planning and satisfaction (Huang, Goo, Nam, & Yoo, 2017), **IoT** supplies the customers with the following services: a. Mobile crowd sensing in smart cities to avoid traffic jam or unpleasant surprise. b. Transportation availability. c. Geographical on line Services. d. Weather forecasting. e. Checking of the flights by a smart device. f. Tracking Rental Cars. g. Making more efficient Customer Processes. h. Searching for hotels and booking rooms even at the last minute. i. Giving real time information to customers about their lost luggage. j. Providing real time parking information. k. Checking health issues if customers are disabled or ageing people, providing them with the best traveling conditions.
The common definition of **Big Data** is based on their essential characteristics, described by the 3Vs: Volume, Variety and Velocity (Laney, 2001). Big data analytics allows us to understand tourists' behaviour, their choices and preferences and, thereby, improving tourism marketing offers. Following these three strands it is possible to base academic education of the tourist operators.	According to Li, Xu, Tang, Wang, and Li (2018), Big Data are produced with the following percentage distributions: 47% are user-generated content (21% are images entered on social media such as Facebook and Instagram, the 26% are textual data, such as reviews and blogs data for lodging, eating and traveling); 17% of data derive from transactions (at least 11% are data generated by Web searches, while 6% are data related to reservations, booking, commercial data of consumers); 36% of the data comes from devices (such as smart phones or tablets). They concern 21% data coming from GPS 4% from Mobile Roaming Data, 3% from Bluetooth data, 5% from RFID data, 1% from WIFI data, 2% from Meteorological data. Analysing images and texts (**Big data** analytics) it is possible to identify consumers' preferences. This leads stakeholders to customize tourist offers in relation to customer needs (Giglio, Bertacchini, Bilotta, & Pantano, 2019b; Wise & Heidari, 2019, pp. 21–29). Consumers will gain extra benefits by obtaining special treatment or discounts, while companies will increase more and more the satisfaction and loyalty of their secure consumers.
Autonomous robots are intelligent machine able to carry out tasks without human intervention. They represent a mature technology that are entering the hospitality and tourism field with more complex and adaptive tasks.	**Robots** are now used in the tourism industry to enhance consumer experience: in China they have been employed as waiters (Cheong, Lau, Foo, Hedley, & Bo, 2016) or to welcome guests at the reception desk in Japan (Zhong, Sun, Law, & Zhang, 2020). Van Doorn et al. (2017) in their survey highlighted the positive customers' responses to these new technologies in relation to the hotel services and their increased purchase intention.
Cyber security represents a key aspect in the 4.0 industry framework. Due to the huge amount of traces that consumers leave in physical cyber systems, data security is a central aspect in all types of transactions in order to allow consumers to access network products and services safely. Consequently, all technologies can bring security problems that can range from simple threats to massive attacks which can cause the entire system to collapse. For these reasons, several metrics are available to front of cyber-attacks, in order to promptly evaluate the level of risk and the properly react.	Key benefits of Cyber **security** are related to privacy, transparency inside the organization, prevention from fraudulent attacks, and prevention from any kind of physical troubles to ensure the highest level of physical and digital security.
Artificial Intelligence (AI) technologies, based on **Machine Learning** (ML), allow to analyse data and learn from them without human intervention (Lee, 2015). Usually, these algorithms can be embodied into smart assistants able to recognise spoken language and learn from users.	In the context of Business management support, **AI** will bring the following benefits to the tourism societies: 1. Improvement of decision making and strategic planning; 2. Improving of the organization functionality; 3. Automation of tasks. In the context of customers analytics, **AI** is used primarily in relation to marketing tourism destinations (Line et al., 2020; Peceny, Urbančič, Mokorel, Kuralt, & Ilijaš, 2019), allowing to identify: a) specific target group of clients; b) informing about the possibility of customers to access last minute products

(*continued on next page*)

Table 1 (*continued*)

INDUSTRY 4.0 TECHNOLOGIES	APPLICATIONS IN THE TOURISM AND HOSPITALITY FIELD
	and services; c) conducting effective up-selling and cross-selling campaigns; d) customer segmentation; e) optimization of tourism activities; f) tracking customer behaviour over time; g) analysis of customer behaviour; h) analysis of tourism destinations trends.
Simulation processes have been used in contemporary science for many years and are related also to Computer Graphics and Computer Animations that have a dynamic output or mathematical results (Bertacchini, Bilotta, Caldarola, & Pantano, 2019; Bertacchini, Bilotta, Caldarola, Pantano, & Bustamante, 2016). Simulation and visualization processes are in turn computer-generated environments such as Virtual Reality, but here the aim is not interaction or entertainment, but above all the possibility of providing data, processed in a short time by large computing capacities and in a short time for scientific purposes. Simulation processes are the basis of scientific calculation.	The applications of simulation and related mathematical models make it possible to measure tourism in its many variables and dynamics: to evaluate tourist flows and their direct, indirect and induced effects on macro, micro environmental, socio-cultural and economic scenarios (Sedarati, Santos, & Pintassilgo, 2019). Thanks to the adoption of simulation techniques, political-strategic planners can attain benefits in the tourism field, to improve the services for the final customers (Baggio, 2019).
Smart Manufacturing (Zheng et al., 2018) is a new approach linked to advanced innovation related both to the production processes and final products that consumers buy and use. The fundamental principles are sustainability, shared services, quality of service, sharing of resources and networking (Kusiak, 2018).	**Smart Manufacturing** is a new approach foresees the active involvement of users and their experience of use (User Experience), both with the development of questionnaires or focus group methods, and with the use of specific digital equipment (such as the eye-tracker and video-cameras) to embed users' perception in the creation of tourism products and services through a co-design process.
The aim of **Cyber-Physical Systems** (CPS) is to acquire, to manage and to analyse high volume data (Big Data) in real-time from the physical world and from the cyber space (Xu & Duan, 2019). This contribute to reduce human errors and to improve workers' ability in problem-solvers. Consequently, it can guarantee a high system efficiency, with low cost and low consumption of resources (Lee, Bagheri, & Kao, 2015).	The benefits for **CPS** are the same of those described with the already described benefits for IoT systems.

[5] Which skills can be immediately employed?

In the following section, we will briefly illustrate the main technologies of Industry 4.0 and the benefits that the tourism field can achieve applying them to supply new and advanced services.

2.2. Industry 4.0 technologies applied to tourism education

Tourism is recognised as a strategic sector that can contribute to the general wealth growth of a country (Romita, 2008, pp. 7–23). In the Industry 4.0 framework, new organizational systems are giving a considerable boost to foster "smart tourism" (Gretzel, Sigala, Xiang, & Koo, 2015) and "smart tourism destinations" (Lamsfus, Martín, Alzua-Sorzabal, & Torres-Manzanera, 2015, pp. 363–375). For this reason, it is needed to train correctly the future professionals who will work in the tourism and hospitality field focusing on all aspects of Industry 4.0 technologies can promote. Hence, from the literature review, we highlighted potential technical and economic benefits that education can gather from each pillar of I4.0 (see Table 1).

Of course, leaving aside the more technologically oriented skills of the I4.0, which concern the engineering implementation of systems such as CPS, IoT and VR or AR, we considered to provide tourism students with the more useful knowledge and tools easy to learn, to be promptly applied in the tourism field. According to Peceny et al. (2019) societal marketing strategies will include monitoring of both the tourist and host satisfaction. Since monitoring is dependent on data, access to them is increasingly relevant to the tourism sector as well. Then, through a careful analysis of the literature, we identified the pillars elements that can be usefully integrated in a new curriculum for Tourism Science. As highlighted in recent researches (Giglio et al., 2019b; Line et al., 2020; Wise & Heidari, 2019, pp. 21–29), Big Data and Machine Learning are currently used to analyse consumer behaviour from different perspectives. Hence, these techniques and tools well established in the framework of Industry 4.0 have been one of the focus of the course. Moreover, as Brown (2008) and Stickdorn, Hormess, Lawrence, and Schneider (2018) showed, the design thinking approach can be adopted in different field to "unmet" customer needs to creating for. Thus, students used this approach to design tourism communication systems centred on customers and tourism organisations requirements.

3. Methodology

The methodological approach presented in this section takes advantages from the constructivist approach to learning that suggests a full and active involvement of students in the learning context. According to Ackermann (2001), the learner constructs meanings through direct experience, handling tools capable to stimulate thinking, learning and new knowledge acquisition. Hence, to plan a specific training able to meet to tourism students requirements, we first analysed the nine technological pillars of I4.0, organizing some introductory lessons on these topics. So, we presented a comprehensive and multidimensional framework on the use of these

Table 2
Course organization details.

Face to face lessons	•**General Psychology topics** •**Industry 4.0 framework, Industry 4.0 technologies and their application in tourism field (see** Table 1)
Project assignment	In order to pass the examination, students had to develop a project, applying the Design thinking approach (Stickdorn et al., 2018) and using software tools and methodologies learnt during the course. The assignment foresaw to "plan, design and develop a communication system, to promote a Calabrian location". Students could develop a digital brochure, a website, a spot or a blog to advertise attractiveness of the chosen location. With regard to the design and implementation of the communication system, students had to: 1) Select a Calabria location; 2) Use collected data on natural, historical and cultural points of interest, together with geographical and demographic information; 3) Design a simulated communication system; 4) Implement a running prototype; 5) Test the implemented system, running a user experience with at least five subjects to collect errors or critical points of the system; 6) Delivery the final project, showing their work to selected stakeholders.
Hands-on Lab	Hands-on laboratory provided students with technical tools to learn programming concepts useful to develop their final project applying the Design Thinking approach. As regards this latter approach, following Marc Stickdorn et al. (2018), we provided some basic elements of the Design Thinking approach to allow students to build tourism communication systems focused on clients and tourism organisations requirements. Inspired by the techniques and tools used by the designer in the development of innovative projects, the purpose of Design Thinking is to improve the quality and interaction between service providers and customers and to identify innovative solutions to a given problem that meets the 3 criteria: desirability on the part of the market or the players involved; technological, technical and organizational feasibility; economic profitability. The result can be achieved through a structured method in 6 steps: 1. Identification of the problem and main objective of the tourism communication systems; 2. Context identification (Data and key actors); 3. Exploration and search for opportunities; 4. Involving customers by making workshop, on line surveys, customers' experience; 5. Concept, prototyping, testing and validation by allowing user experience of the prototypes; 6. Implementation (if necessary, involve customers again). During the "Hands-on Lab" phase, students learnt to: 1) Search and collect data from social media; 2) Select and classify data; 3) run Big Data analysis. **1. Data collection from social media** First of all, students learnt to acquire both image and textual data from Social Media by using the Mathematica software (Wolfram, 2017), employing function and algorithms that allowed them to access to different services on the network, to collect different kinds of data, such as text, audio, video, images. Wolfram Mathematica with its interactive sequences of inputs and outputs, is an ideal way to learn, explore and write programs. It is specifically set up for easy access in learning the Wolfram language. User has to know Wolfram Language. "With its intuitive English-like function names and coherent design, the Wolfram Language is uniquely easy to read, write, and learn" (https://www.wolfram.com/mathematica/). It is currently used in education, as well as very widely used in industry, because it is powerful and easy to learn, accessible to anyone. In particular, students learnt to use the function *ServiceConnect ["Flickr"],* instantiating a connection to Flickr through a query. This procedure allowed them to collect photos taken by tourist from Flickr, related to the city chosen as target of their analysis. Regarding textual data, Wolfram Mathematica allows students to collect recent tweets using specific hashtags concerning the selected locations, or other kinds of information, using the Mathematica connection algorithms. Students learned to collect Tweet, reviews and Images. ***2. Selection and classification of data collected*** Students learnt to classify the collected information on the selected locations in three main categories: 1) Tourism site facilities; 2) Geographical, Historical and Cultural attractions and 3) Tourists' Behavioural variables. The analysis aimed to understand tourists' behaviour: how do they show their emotions, how do they behave in places of leisure and what do they like to photograph most. A fundamental element of this process concerns the visualization of geo-referenced data in Mathematica. This goal is achieved through the function *GeoGraphics* that displays the data related to the selected cities on a map. Moreover, the function *CityData* that provides a list of the full specifications and property for the city, for instance population, coordinates, elevation and more. As regards tourist facilities, students learnt to find health & fitness services, accommodation facilities, big and variety of food present in the place, environmental safety & typical food of the place, transportation facilities. With regard to geographical, historical and cultural attractions data, students had to focus on the types of images that are present in Social Media, the historical and archaeological resources present for the chosen location, the benefits expectations in terms of the quality of the stay and the services offered, the relevant historical and cultural resources. Instead, student learnt to the analyse tourist behaviour according to the following variables: the requests and wishes of the tourist regarding the exploration of the cultural places, adventure search, enjoying night life & shopping opportunities, the search for novelties, the emotions in photos and texts posted on Social Media, while the tourists carried out the typical activities of exploration, shopping, entertainment, etc. ***3. Big Data analysis*** To analyse data students used Artificial Intelligence tools. In particular, they learnt to analyse textual data and images by using unsupervised learning algorithms. Hence, they learnt some key concepts of programming and some Wolfram Mathematica functions. They applied sentiment analysis using *Classify function* to analyse collected tweets, reviews and other textual data extracted from social media with the aim to identify emotional contents. *Classify function* is a pre-trained Machine Learning algorithm. Indeed, it has a built-in pre-trained module "Sentiment" allowing to recognise emotion that a snippet of text conveys. Subsequently, students analysed images. As far as the expression of emotions they applied *FacialExpression function.* This function has a built-in classifier that automatically chooses the best algorithm to adopt according to the available models built and trained through a large Wolfram database (Net Neural Repository) to identify the right emotion in an image and label each picture into different categories. To obtain information on points of interest that the tourist visited in a city, students applied *ImageIdentify* function that is a pre-trained Machine Learning algorithm that identifies the objects included in the pictures (church, monument, people, squares, etc.)

technologies in the tourism enterprises. At the end of each lesson, we brainstormed the potential of these technologies, and with the feedback of the students we were able to build the conceptual basis from which to build the set of technologies that are ready to be used in the *curriculum*.

3.1. Course contents

The experimental work program was given in the academic year of 2018–2019, in the General Psychology class, Course Degree in Tourism Science (University of Calabria), involving 30 students (27% male and 73% female). Lessons were held twice a week for 2 h for a total of 42 h. All lessons have been given in a Lab environment.

Face-to-face lessons were aimed to provide key concepts of General Psychology, Industry 4.0 and the related technological trends. Hands-on hours were focused on technological tools learned. A detailed description of the activities is sketched in Table 2.

3.2. Method of evaluation of the final project

The examination aimed to verify the student's ability to use the information acquired in the various areas of intervention. In particular, the assessment of learning have been place evaluating the final project according the criteria defined in Table 3.

3.3. Students' course evaluation questionnaire

At the end, students evaluated the academic course they attended by answering a questionnaire. The questionnaire was subdivided in two sections. The first section is related to the quality of the face-to-face activities and the usefulness of the technological tools provided (see Table 4). This section comprised 7 items. The second section was related to the teaching approach adopted by the professor and comprised 5 items. Students responded to the questionnaire items by choosing one of the suitable answers on a five-point Likert scale, from 1 – total disagreement, to 5 – total agreement. They had to indicate the level of agreement that mostly reflected their opinions about the course and the teaching approach adopted by the professor. The survey was developed by using a Google Forms that was sent by email to 30 students attending the course. Answers were collected anonymously, so that the participants could freely express their opinion. The statistical analysis on the collected data was conducted through SPSS IBM 22.0.

4. Results

4.1. Final project results

During the course the students worked to the assigned project, planning, designing and developing a communication system aimed at promoting a Calabrian location. Focusing their attention on the services offered by the location or on the landscape attractiveness or on the historical cultural heritage, they had to follow guidelines, methodologies and approach presented to the students during the course.

Working in groups of two, students designed and implemented fifteen communication systems concerning different Calabrian cities. They used different software, starting from a concept outline to create a creative advertising of the chosen locations. In particular, 3 groups developed a Website; 3 groups used the collected digital information to implement an advertising spot; 2 groups prepared a promotion video, while 1 group developed a promotion video associated to a digital brochure. 3 groups assembled a Prezi presentation for promoting the chosen city. 2 groups developed a news-based blog, broken up into categories such as "Tourism," "Food & Beverage", "Historical sites". 1 group produced a very creative and original spot to promote the tourism location: two students used a drone to record some videos. Then, they made a final product with different kinds of information collected during the course and with

Table 3
Evaluation rubric of the final project.

	Excellent	Good	Sufficient
Design thinking approach	Followed all steps	Followed all steps	Followed a few steps
Mathematica functions	Used all functions	Used a few functions	Used at least a function
Communication system	Very high level of accuracy in the integration of audio, video, images collected with textual information. Final product designed taking into account the target audiences and their aim to promote the chosen tourism location from different point of view. Creation of new materials to be integrate into the system.	High level of accuracy in the integration of audio, video, images collected with textual information. Final product designed taking into account the target audiences and their aim to promote the chosen tourism location from different point of view.	Medium level of accuracy in the integration of audio, video, images collected with textual information. Final product designed taking into account the target audiences and their aim to promote the chosen tourism location from different point of view.
Stakeholders involvement	Tested the system involving local stakeholders	Tested their selves the system	None test

Table 4
Average (mean) and the standard deviation (SD) of the score in the Likert scale for the distribution of participants' ANSWERS.

FEEDBACK ON COURSE ORGANIZATON AND EDUCATIONAL CONTENTS	Mean	SD
[Q1] The exams were well related to the course contents	4.50	.630
[Q2] The specific objectives for this course were achieved in short time	4.50	.675
[Q3] The classroom atmosphere was conductive	4.40	.621
[Q4] I am glad that I attended this course	4.40	.640
[Q5] The expectations for this course have not been achieved	3.93	.774
[Q6] The course provided useful technological tools to analyse tourist behaviour	1.77	.728
[Q7] The technological software used are relevant to investigate tourist dynamics	4.43	.682
TEACHING APPROACH		
[Q8] My experience during the completion of this course was not satisfied	4.50	.629
[Q9] The teacher was very knowledgeable about the topics	4.50	.572
[Q10] The teacher was not well prepared for this course	1.33	.606
[Q11] The teacher motivated me to learn more about the topics	4.50	.777
[Q12] Overall evaluation very good	4.43	.626

their own videos. Fig. 1 shows an example of diagram sketched by a group of students to design their digital Communication System of Acri city, a small location of Calabria region.

In the students' work, the most important information for the tourism field has been gathered by social media such as Flicker, Facebook, etc. (images of people and environments pictures, other media on the activities carried out by tourists in the chosen locations). In particular, students were able to obtain information on the geo-localized position of the tourist, the points of interest that the tourist visited in a city, especially related to monuments, churches, museums, etc. In fact, as underlined by Pantelidis (2010), the retrieval and analysis of this valuable information can thus significantly help experts in the valorisation of a place. Furthermore, sentiment analysis of the social media texts, mainly focused on one psychological viewpoint necessary to recognise emotion and social phenomena. These factors might be relevant indicators in the assessment or prediction of the attitudes and behaviour of online communities (Miháltz et al., 2015, pp. 127–133).

At the end of the course, marks were assigned according to the criteria defined in Table 3 and they reflected the level of knowledge and skills acquired by students along the educational path.

In particular, it emerged that the overall performances of the tourism students were of high quality. In fact, 46% of the students received an "Excellent" score. They followed all steps suggested by the Design thinking approach and from a methodological point of view, used all Mathematica functions learnt during the course. The developed communication system presents a very high level of accuracy as regards audio, video, images and textual information. Their final product was designed taking into account the target audiences whom it was addressed and their aim to promote the chosen touristic location from different point of view (such as facilities, cultural heritage, landscapes). Moreover, they created new materials to integrate into the system (for example some videos clip with a drone or original textual information). They tested their product involving local stakeholders, then they modified their products taking into account the received suggestions. 40% of students had a "Good" mark. Followed all steps suggested by the Design thinking approach, however they used only few functions learnt during the course. Their communication system present a high level of accuracy in the integration of audio, video and images collected with textual information. Their final product was designed taking into account the target audiences and the aim to promote the chosen location from different point of view. However, they tested the developed communication system without involving local stakeholders. Only 14% of the students got a "Sufficient" mark to the final exam. They

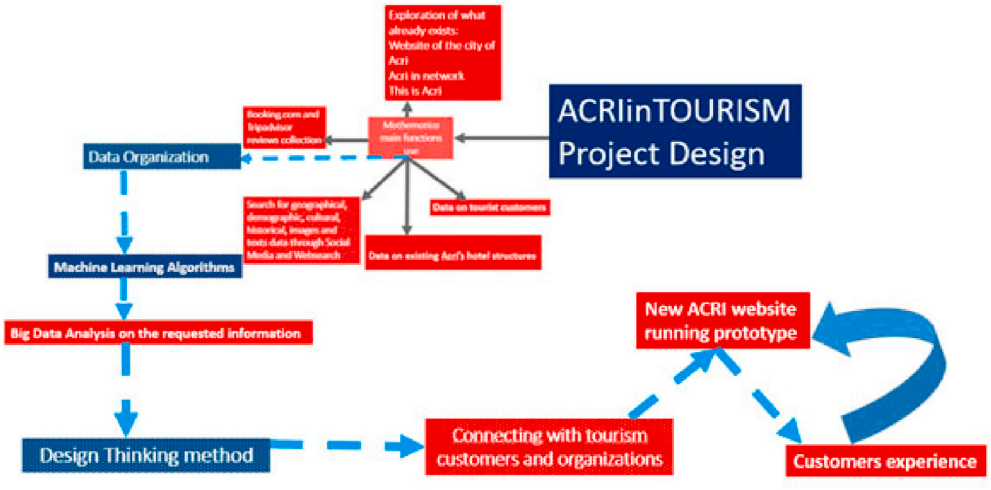

Fig. 1. Diagram of a digital Communication System developed for the project ACRIinTOURISM.

followed a limited number of the suggested steps and applied only few Mathematica functions. Their communication system presents a medium level of accuracy. Even if the final product was designed taking into account the target audiences (for example age and status), yet they did not test their final product from any point of view. However, they pointed out several attractions, services and facilities offered by the chosen place.

4.2. Questionnaire results

All students filled in the questionnaire evaluating the face-to-face activities and the usefulness of technological tools provided during the course. A descriptive analysis of the 30 questionnaires collected has been run with SPSS 22.0. Table 4 shows the average and the standard deviation of the score in the Likert scale for the distribution of participants' answers. In particular, the central tendency value (mean) suggests what the 'average' respondent thinks and standard deviation allows to understand the variability of the answers.

Results show how students have appreciated topics, tools and techniques introduced during the course, as well as they learned how to apply the different I.4.0 technologies in the tourism field to better understand and satisfy tourist need. This latter data are confirmed by the high percentage of students (97%) have agreed with the sentence "the course provided useful technological tools to analyse tourist behaviour". In the opinion of 93% of students a key role was played by the positive, organized, outgoing and confident classroom climate ("The classroom atmosphere was relaxed") and for 90% of the students it is due to the ability of the professor to motivate students in approaching new scientific tools ("The teacher motivated me to learn more about the topics"). 93% of students evaluated positively the whole course and the teaching approach, stating to be satisfied with it (83% of the students).

Fig. 2 shows for each question the percentage of agreement (orange) or disagreement (blue) across all students' answers. We did not take into account answers corresponding to the score 3 (I don't kown) in the Likert scale. Q5, Q8 and Q10 are control questions (that use negative sentence) used to prevent random answers.

In summary, from the analysis of the questionnaires, we understood that the educational course has been appreciated for its potentialities in better modelling the tourism professional's activities, adapting to technological requirements of contemporary digitally oriented customers.

5. Discussion and conclusions

The aim of this study is to develop a Tourism 4.0 Curriculum for Tourism Sciences students, at the University of Calabria. As researchers previously established in tourism field (Giglio, Bertacchini, Bilotta, & Pantano, 2019a; Giglio et al., 2019b) and with a

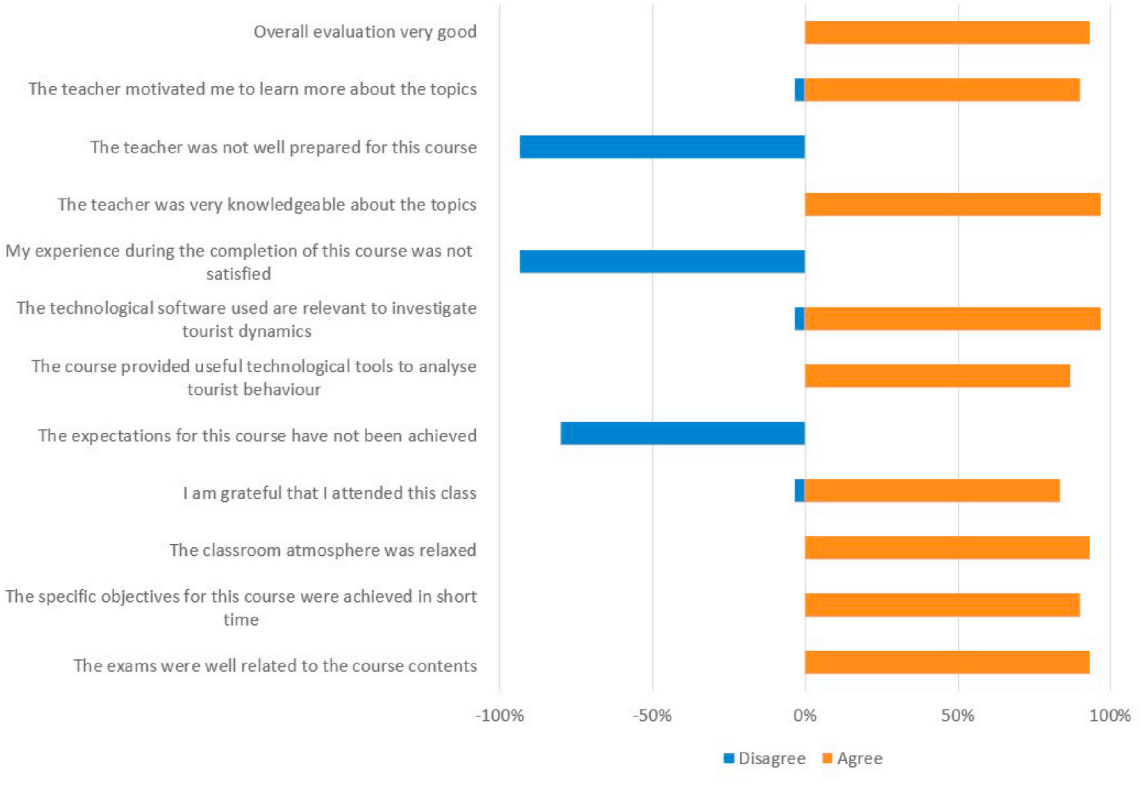

Fig. 2. It SHOWS for each question, the percentage of agreement (orange) or disagreement (blue) across all students' answers. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

proven track record in the field of educational technologies ((Bertacchini, Bilotta, Gabriele, Pietro, & Tavernise, 2013)Cárdenas et al., 2016; Gabriele et al., 2019; Gabriele, Marocco, Bertacchini, Pantano, & Bilotta, 2017; Giglio et al., 2015, pp. 703–708), we developed a laboratory based on Industry 4.0 technologies, in order to encourage technological changes in Tourism and Hospitality education. Airey, Tribe, Benckendorff, and Xiao (2015) and Stansbie and Nash (2016) highlight how tourism is a well-established topic in some academic institutions, while overall it undergoes a long tail of relatively low performance. Educational programs only preferably offer a combination of the Tourism 4.0 knowledge and skills, useful to enhance students' knowledge for the professional career path. In this perspective, academic researchers have a key role in ensuring the quality and the effective dissemination of the new technological frontiers of knowledge. So replying to the questions posed before, we propose on the following a discussion on the points mentioned in section 2.1.

What are the benefits of applying Industry 4.0 technologies in the field of tourism?

Tourism students, trained on Industry 4.0 technologies could play an important intermediary role between tourism professionals and the new I4.0 technologies.

Thus, applying new technologies to tourism market, they can really support tourism operators in take on new challenges due to tourism 4.0, to promptly reply to the tourism market demands and to customers' requirements in a technologically advanced world.

In fact, we hypothesized that, once trained, students could create communication systems able to incorporate knowledge derived from technologies for the implementation of advanced tourism systems or services such as apps, websites, blogs, and social media profile, connecting the regional realities of the operators with new market opportunities. In this way, it will be possible to create new, useful and fruitful employment opportunities in the tourism field actively involving local stakeholders.

A flexible professional profile should be created. This professional operator should be able to understand the needs of technological innovation in the tourism field, and be able to create systems in line with the occurring industrial revolution. In essence, students have to realize they can have a key intermediary role between scientific research on new technologies and local stakeholders, whereas this process of dissemination of technological culture could lead to significant benefits and sustainable economies in the tourism field.

What are the crucial and necessary knowledge and skills to create a successful curriculum for students at the end of a Course Degree in Tourism Science?

We provided students with a set of ready-to-use and easy-to-use algorithms that allow a number of important functions, such as collecting geo-referenced, historical-cultural, demographic and customers' data. Applying the advanced techniques learnt, students can indirectly analyse customers' behaviour such as emotions, tastes, preferences of places, cultural preferences. Moreover, big data and artificial intelligence technologies, some of the I4.0 top technologies, allow to follow the tourist in the holiday resorts, analyzing all the digital traces he leaves, his evaluations of the places, his preferences. These data can then be further used to create personalised tourist routes, in line with consumer profiling. Obviously the collected dataset represents a rich and precious source of information that must be opportunely used for new aims. For this reason, Design Thinking is an excellent approach for developing creative and suitable products as highlighted from (Henriksen, Richardson, & Mehta, 2017). The relationship with customers that this type of approach foresees, allows one to acquire a variety of methods of analysis of user needs and to customize the services that can be offered in the tourism industry.

What conceptual skills do students need to have?

We found that the open discussions took place after the lessons were really important to develop critical skills in the students. In practice, discussions allowed participants to understand the implications of Industry 4.0 framework on the tourism market, on the tourism education and in the scientific research, both from a global and specific perspective. In addition, subsequent contacts students had with the costumers and stakeholders were useful in stimulating in them a conceptual awareness of the general industrial landscape, providing them with a method for their future activity. In fact, the Design Thinking approach allowed students to design innovative communication systems and develop conceptual skills to understand how motivate tourists and to find innovative solutions customers-centred.

What technological skills do students require?

We have identified a set of technological skills that concern the collection of data and their analysis, the creation of intelligent algorithms that allow, given a problem, to arrive at its solution. For the moment, they are a series of functions, which represent a first operational nucleus that can be increased more and more, according to the customers' needs and to better understand the tourist employee profile in light of the changed social, environmental and technological conditions of people and organization in the contemporary era.

Which skills can be immediately employed?

We think that the skills we have provided in the lab lessons are immediately employable. We are aware of starting an educational perspective in the tourism field based on the transfer of knowledge, usually held by specialists in the related scientific sector or several sectors (such as Artificial Life, Machine Learning Analytics, Big Data and so on).

6. Limitations and future work

Nevertheless, even if empirical and still not experimental, this research should provide teachers, educators and policy makers with clear and immediately applicable indications on the effectiveness of the adopted approach, of educational techniques and programs of renewal of education systems. In other words, it will provide us with suggestions on "what works", "under what circumstances", "within which context", "through which type technologies", "what skills will be developed in the students"? "How are these skills related with the professional work in the tourism field?"

A lot of work remains to be done from an organizational and experimental point of view. Even though our work is still completely

empirical and not based on an experimental plan, it was an important contribution as it provided us with a picture of how students can be successfully motivated to become business and knowledge promoters also in daily life situations. Driven by the pragmatism of the approach and the ease of use of the proposed methods, interacting with local stakeholders to elaborate their projects, students have really worked at their best, implementing communication systems, with great ability. In agreement with the Course Degree in Tourism Science of our University, we planned to organize a more extensive laboratory to improve the educational program focused on Industry 4.0 technologies and its applications in tourism and hospitality presented in this article.

CRediT authorship contribution statement

Eleonora Bilotta: Formal analysis, Writing - review & editing. **Francesca Bertacchini:** Formal analysis, Writing - review & editing. **Lorella Gabriele:** Formal analysis, Writing - review & editing. **Simona Giglio:** Formal analysis, Writing - review & editing. **Pietro Salvatore Pantano:** Formal analysis, Writing - review & editing. **Tullio Romita:** Formal analysis, Writing - review & editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhlste.2020.100275.

References

ABB. (2016). *A new age of industrial production the Internet of Things*. Services and People. https://new.abb.com/docs/default-source/technology/a-new-age-of-industrial-production—iotsp.pdf. (Accessed 22 February 2019).

Ackermann, E. (2001). Piaget's constructivism, Papert's constructionism: What's the difference? *Future of learning group publication, 5*(3), 438.

Airey, D., Tribe, J., Benckendorff, P., & Xiao, H. (2015). The managerial gaze: The long tail of tourism education and research. *Journal of Travel Research, 54*(2), 139–151.

Baggio, R. (2019). Measuring tourism: Methods, indicators, and needs. In C. Cooper, & E. Fayos-Solà (Eds.), *The future of tourism: Innovation and sustainability* (pp. 255–269). Heidelberg: Springer.

Benešová, A., & Tupa, J. (2017). Requirements for education and qualification of people in Industry 4.0. *Procedia Manufacturing, 11*, 2195–2202.

Bertacchini, F., Bilotta, E., Caldarola, F., & Pantano, P. (2019). The role of computer simulations in learning analytic mechanics towards chaos theory: A course experimentation. *International Journal of Mathematical Education in Science & Technology, 50*(1), 100–120.

Bertacchini, F., Bilotta, E., Caldarola, F., Pantano, P., & Bustamante, L. R. (2016). Emergence of linguistic-like structures in one-dimensional cellular automata. October. In *AIP conference proceedings* (Vol. 1776). AIP Publishing LLC, 090044.

Bertacchini, F., Bilotta, E., Carini, M., Gabriele, L., Pantano, P., & Tavernise, A. (2012). Learning in the smart city: A virtual and augmented museum devoted to chaos theory. In *International conference on web-based learning* (pp. 261–270). Berlin, Heidelberg: Springer. September.

Bertacchini, F., Bilotta, E., & Pantano, P. (2017). Shopping with a robotic companion. *Computers in Human Behavior, 77*, 382–395.

Bertacchini, F., Bilotta, E., Gabriele, L., Pietro, P., & Tavernise, A. (2013). Toward the use of Chua's circuit in education, art and interdisciplinary research: Some implementation and opportunities. *Leonardo, 46*(5), 456–463. https://doi.org/10.1162/LEON_a_00641

Bradlow, E. T., Gangwar, M., Kopalle, P., & Voleti, S. (2017). The role of big data and predictive analytics in retailing. *Journal of Retailing, 93*(1), 79–95.

Brown, T. (2008). Design thinking. *Harvard Business Review, 86*(6), 84.

Cárdenas, L. A. V., Tavernise, A., Bertacchini, F., Gabriele, L., Valenti, A., Pantano, P., et al. (2016). An educational coding laboratory for elementary pre-service teachers: A qualitative approach. *International Journal of Engineering Pedagogy (iJEP), 6*(1), 11–17.

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly, 36*(4).

Cheong, A., Lau, M. W. S., Foo, E., Hedley, J., & Bo, J. W. (2016). Development of a robotic waiter system. *IFAC-PapersOnLine, 49*(21), 681–686.

Dregger, J., Niehaus, J., Ittermann, P., Hirsch-Kreinsen, H., & ten Hompel, M. (2018). Challenges for the future of industrial labor in manufacturing and logistics using the example of order picking systems. *Procedia CIRP, 67*, 140–143.

Gabriele, L., Bertacchini, F., Tavernise, A., Leticia, V. C., Pantano, P., & Bilotta, E. (2019). Lesson planning by computational thinking skills in Italian pre-service teachers. *Informatics in Education, 18*(1), 69–104.

Gabriele, L., Marocco, D., Bertacchini, F., Pantano, P., & Bilotta, E. (2017). An educational robotics lab to investigate cognitive strategies and to foster learning in an arts and humanities course degree. *International Journal of Online Engineering (iJOE), 13*, 7–19, 04.

Giglio, S., Bertacchini, F., Bilotta, E., & Pantano, P. (2019a). Using social media to identify tourism attractiveness in six Italian cities. *Tourism Management, 72*, 306–312.

Giglio, S., Bertacchini, F., Bilotta, E., & Pantano, P. (2019b). Machine learning and point of interests: Typical tourist Italian cities. *Current Issues in Tourism*, 1–13.

Giglio, S., Gabriele, L., Tavernise, A., Pantano, P., Bilotta, E., & Bertacchini, F. (2015). Virtual museums and calabrian cultural heritage: Projects and challenges. September. In *Digital heritage* (Vol. 2). IEEE. *2015*.

Gretzel, U., Sigala, M., Xiang, Z., & Koo, C. (2015). Smart tourism: Foundations and developments. *Electronic Markets, 25*(3), 179–188.

Henriksen, D., Richardson, C., & Mehta, R. (2017). Design thinking: A creative approach to educational problems of practice. *Thinking Skills and Creativity, 26*, 140–153.

Huang, C. D., Goo, J., Nam, K., & Yoo, C. W. (2017). Smart tourism technologies in travel planning: The role of exploration and exploitation. *Information & Management, 54*(6), 757–770.

Ivanov, S. H., & Webster, C. (2017). Designing robot-friendly hospitality facilities. October. In *Proceedings of the scientific conference "Tourism. Innovations. Strategies.* Bulgaria: Bourgas. October 2017, 74-81.

Jovicic, D. Z. (2019). From the traditional understanding of tourism destination to the smart tourism destination. *Current Issues in Tourism, 22*(3), 276–282.

Kaasinen, E., Schmalfuß, F., Özturk, C., Aromaa, S., Boubekeur, M., Heilala, J., & Mehta, R. (2020). Empowering and engaging industrial workers with Operator 4.0 solutions. *Computers & Industrial Engineering, 139*, Article 105678.

Kagermann, H., Lukas, W. D., & Wahlster, W. (2011). Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. industriellen Revolution. *VDI Nachrichten, 13*(11), 2.

Krugh, M., & Mears, L. (2018). A complementary cyber-human systems framework for Industry 4.0 cyber-physical systems. *Manufacturing Letters, 15*, 89–92.

Kusiak, A. (2018). Smart manufacturing. *International Journal of Production Research, 56*(1–2), 508–517.

Lamsfus, C., Martín, D., Alzua-Sorzabal, A., & Torres-Manzanera, E. (2015). Smart tourism destinations: An extended conception of smart cities focusing on human mobility. In Z. Xiang, & I. Tussyadiah (Eds.), *Information and communication technologies in tourism 2014*. Cham: Springer.

Laney, D. (2001). 3D data management: Controlling data volume, velocity and variety. *META group research note, 6*(70), 1.

Lee, J., Bagheri, B., & Kao, H. A. (2015). A cyber-physical systems architecture for industry 4.0-based manufacturing systems. *Manufacturing letters, 3*, 18–23.

Line, N. D., Dogru, T., El-Manstrly, D., Buoye, A., Malthouse, E., & Kandampully, J. (2020). Control, use and ownership of big data: A reciprocal view of customer big data value in the hospitality and tourism industry. *Tourism Management, 80*, Article 104106.

Li, J., Xu, L., Tang, L., Wang, S., & Li, L. (2018). Big data in tourism research: A literature review. *Tourism Management, 68*, 301–323.

Miháltz, M., Váradi, T., Csertő, I., Fulop, É., Pólya, T., & Kővágó, P. (2015, September). Beyond sentiment: Social psychological analysis of political Facebook comments in Hungary. In *Proceedings of the 6th workshop on computational approaches to subjectivity, sentiment and social media analysis*.

Pantano, E., Giglio, S., & Dennis, C. (2018). Making sense of consumers' tweets: Sentiment outcomes for fast fashion retailers through Big Data analytics. *International Journal of Retail & Distribution Management, 47*(9), 915–927.

Pantelidis, I. S. (2010). Electronic meal experience: A content analysis of online restaurant comments. *Cornell Hosp Q, 51*, 483–491.

Peceny, U. S., Urbančič, J., Mokorel, S., Kuralt, V., & Ilijaš, T. (2019). *Tourism 4.0: Challenges in marketing a paradigm shift. In consumer behavior and marketing*. IntechOpen.

Pfeiffer, S. (2015). *Effects of Industry 4.0 on vocational education and training*. Vienna: Institute of Technology Assessment.

Popkova, E. G., Ragulina, Y. V., & Bogoviz, A. V. (Eds.). (2019). *Industry 4.0: Industrial revolution of the 21st century*. Springer International Publishing.

Rauch, E., Linder, C., & Dallasega, P. (2020). Anthropocentric perspective of production before and within Industry 4.0. *Computers & Industrial Engineering, 139*, Article 105644.

Romita, T. (2008). Turismo, turismi, turisti, 2008. In C. Bezzi, D. Patassini, T. Romita, & M. Scettri (Eds.), *Valutare programmi e progetti di sviluppo turistico*. Milano: Franco Angeli (RIV-Rassegna Italiana di Valutazione, Volume Supplement, 37).

Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P., et al. (2015). Industry 4.0: The future of productivity and growth in manufacturing industries. *Boston Consulting Group, 9*(1), 54–89.

Sedarati, P., Santos, S., & Pintassilgo, P. (2019). System dynamics in tourism planning and development. *Tourism Planning & Development, 16*(3), 256–280.

Shabani, N., Munir, A., & Hassan, A. (2019). E-Marketing via augmented reality: A case study in the tourism and hospitality industry. *IEEE Potentials, 38*(1), 43–47.

Sony, M., & Naik, S. S. (2019). Ten lessons for managers while implementing Industry 4.0. *IEEE Engineering Management Review, 47*(2), 45–52.

Stansbie, P., & Nash, R. (2016). Customizing internship experiences by emphasis area: The key to increased satisfaction and motivation in hospitality and tourism management students. *Journal of Hospitality and Tourism Education, 28*(2), 71–84.

Stickdorn, M., Hormess, M. E., Lawrence, A., & Schneider, J. (2018). *This is service design doing: Applying service design thinking in the real world*. "O'Reilly Media, Inc.

Van Doorn, J., Mende, M., Noble, S. M., Hulland, J., Ostrom, A. L., Grewal, D., et al. (2017). Domo arigato Mr. Roboto: Emergence of automated social presence in organizational frontlines and customers' service experiences. *Journal of Service Research, 20*(1), 43–58.

Wise, N., & Heidari, H. (2019). *Developing smart tourism destinations with the internet of things. In big data and innovation in tourism, travel, and hospitality*. Singapore: Springer.

Wolfram, S. (2017). *An elementary introduction to the wolfram language*. Incorporated: Wolfram Media.

Xu, L. D., & Duan, L. (2019). Big data for cyber physical systems in industry 4.0: A survey. *Enterprise Information Systems, 13*(2), 148–169.

Zheng, P., Sang, Z., Zhong, R. Y., Liu, Y., Liu, C., Mubarok, K., et al. (2018). Smart manufacturing systems for Industry 4.0: Conceptual framework, scenarios, and future perspectives. *Frontiers of Mechanical Engineering, 13*(2), 137–150.

Zhong, L., Sun, S., Law, R., & Zhang, X. (2020). Impact of robot hotel service on consumers' purchase intention: A control experiment. *Asia Pacific Journal of Tourism Research*, 1–19.