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Industry 4.0: Challenges and Opportunities of Tourism and Hospitality Industry in Bangladesh

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ABSTRACT

Purpose: The study's objective is to assess the challenges and opportunities of the Fourth Industrial Revolution (4IR) in the tourism and hospitality (TH) industry in Bangladesh.

Methodology: This exploratory research is designed based on primary and secondary data. A mixed method is used to conduct this research.

Findings: The study found that hotels, tourism destinations, and resorts in Bangladesh are adopting disruptive technologies of the 4IR. In Bangladesh, 34.29 percent of TH stakeholders use 3D printing, 5.71 percent use autonomous robots, 17.14 percent use artificial intelligence (AI), 45.71 percent use virtual reality (VR), 11.43 percent use augmented reality (AR), 51.43 percent use cloud computing and 74.29 percent use biotechnology. Moreover, it was found that the majority of TH stakeholders, i.e., 88.57 percent, are using IoT for various purposes, including security surveillance, marketing campaigns, self-control of room environments via smart transport systems, improving customer services, monitoring occupancy, Wi-Fi control, order taking, and monitoring the entire hotel. This study identifies the challenges of 4IR in the TH industry of Bangladesh and categorizes them into three levels. This study also reveals various opportunities for Industry 4.0 in Bangladesh's TH industry, which are divided into three groups.

Practical Implications: The study suggests that policymakers and practitioners should consider these challenges and opportunities when designing future courses of action for this industry.

Originality: This study assesses the present scenario of the application of disruptive digital technologies in Bangladesh's TH industry and reveals the challenges and opportunities of the TH industry for 4IR.

1.0 Introduction

1.1 Background of the Study

The TH industry is one of those industries that have always incorporated technological advancements associated with the previous industrial revolutions (Osei et al., 2020). All industrial revolutions (IR) occur as innovation, technology, transportation, and

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communication networks combine to provide radically different production processes and service delivery methods that move beyond existing and familiar work patterns and operations (Pettinger, 2020). The 1st IR (1760–1840) began with the construction of the railway and the invention of the steam engine, focusing mainly on mass mechanized production (Schwab, 2017; Tien, 2020). The 2nd IR (Late 1900-Early 2000) initially focused on the invention of electricity and the mass production of products by assembly lines (Schwab, 2017; Tien, 2020). The 3rd IR (1960-Early 2100) was characterized by the widespread adoption of computers and the internet, focusing mostly on mass customization of products, services, or service products (Schwab, 2017; Tien, 2020).

Over the last decade, the term Industry 4.0 has become a common buzzword to embrace disruptive digital technologies internet of things (IoT), big data, 3D printing, autonomous robots, artificial intelligence, virtual reality, augmented reality, cloud computing, self-driving cars, drones, cyber-physical systems, nanotechnology, smart sensors, biotechnology, etc.) in manufacturing processes. Schwab (2017) also noted that 4IR has become ubiquitous due to mobile internet, cheaper, smaller, and more powerful sensors. Although Industry 4.0 is tantamount to a smart factory, it will help transform not just the manufacturing industry but all sectors, such as agriculture, construction, mining, finance, tourism, health, transport, and education (Dadios et al., 2018). Every transformation creates some new opportunities as well as challenges in their related fields. Therefore, this study takes the initiative to assess the challenges and opportunities of 4IR in the TH industry in Bangladesh. This assessment will enable policymakers and practitioners to make more efficient decisions in this field.

1.2 Objectives of the Research

The main objective of the study is to assess the challenges and opportunities of 4IR in the TH industry in Bangladesh. This objective unfolds some specific points, which are;

i. To assess the present scenario of the application of disruptive digital technologies in the TH industry of Bangladesh

ii. To reveal the challenges and opportunities of the TH industry for 4IR

1.3 Research Methodology

This exploratory research is designed based on primary and secondary data. The content approach is used to review different articles and blogs published in recent years on 4IR's introduction and influence on the tourism and hospitality industry. A survey was conducted among conveniently selected 35 respondents from different hotels, motels, parks, museums, and other destinations to assess the present scenario of the application of disruptive digital technologies in this industry. It also collects experts' opinions about the challenges and opportunities of Industry 4.0 in the tourism and hospitality industry. The practitioners, researchers, policymakers, and other related scholars are considered the expert members of this study, and they are also selected based on purposive sampling. The collected data are

analyzed using different statistical tools and techniques and presented using different tables, charts, and graphs.

1.4 Representatives of the Industry

The total number of respondents for this study is 35. Whereas, Figure 1.1 shows that 54 percent represent the hotel sector, 26 percent represent different destinations, and 20 percent represent resorts.

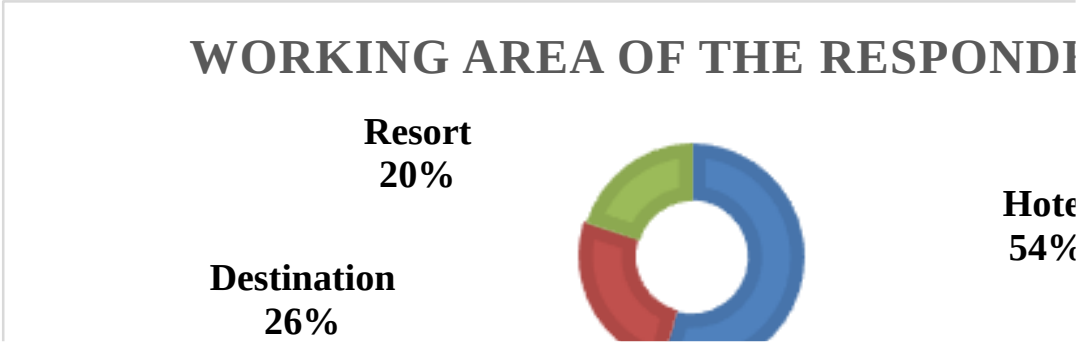

Figure-1.1: Working Area of the Respondents

1.5 Geographical Location of the Destination

The distribution of destinations in the study area varies across divisions. According to the findings, 42.9 percent of the destinations are situated within the Dhaka Division, while 28.6 percent are located in both the Rangpur and Rajshahi Divisions. Chottogram Division accounts for 11.4 percent of the destinations, followed by the Khulna Division with 2.9 percent, and Sylhet Division with 14.3 percent (see Figure 1.2 for a visual representation).

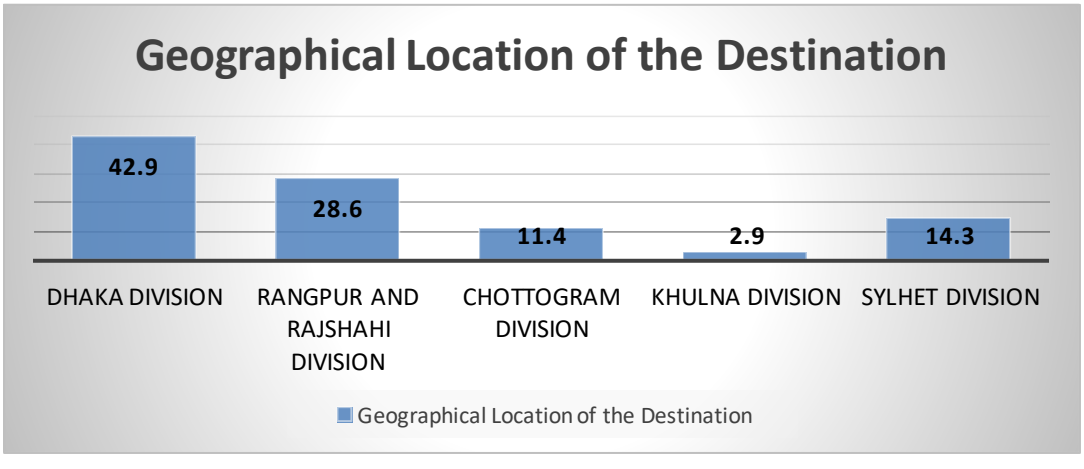

Figure 1.2: Geographical location of the destination

Table 1.1: Division-wise distribution

		Geographical Location of the destination				
		Dhaka Division	Rangpur and Rajshahi Division	Chottogram division	Khulna Division	Sylhet Division
Working Area of the Respondents	Hotel	6 (17.14%)	8 (22.86%)	3 (8.57%)	1 (2.86%)	1 (2.86%)
	Destination	6 (17.14%)	2 (5.71%)	1 (2.86%)	0 (0.00%)	0 (0.00%)
	Resort	3 (8.57%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	4 (11.43%)
Total		15 (42.86%)	10 (28.57%)	4 (11.43%)	1 (2.86%)	5 (14.29%)

Table 1.1 provides a breakdown of the samples collected, with the majority, 42.86 percent, being from the Dhaka Division. Within this division, 17.14 percent represent hotels, another 17.14 percent represent destinations, and 8.57 percent represent resorts. Notably, only one sample was obtained from the Khulna Division. Additionally, a significant portion, 22.86 percent, of the sampled hotels were drawn from the Rangpur and Rajshahi Divisions.

2.0 Industry 4.0: Overview of Bangladesh Tourism and Hospitality Industry

This chapter shows the status of using IoT, big data analysis, 3D printing, autonomous robots, artificial intelligence, virtual reality, augmented reality, cloud computing, biotechnology, blockchain technology, and nanotechnology in the THM Industry of Bangladesh.

2.1 Status of Using IoT in the TH Industry of Bangladesh

The Internet of Things (IoT) refers to a network of physical devices, vehicles, appliances, and other objects equipped with sensors, software, and connectivity. These devices can collect and exchange data over the internet, enabling communication between themselves and human users. This interconnected system forms a vast ecosystem of smart objects (Atzori et al.,2010; Sheng, et al, 2016). The IoT serves as a crucial link between physical and digital applications within the context of the fourth industrial revolution. At its core, it represents the connection between people and various entities such as products, services, and locations, facilitated by interconnected technologies and platforms (Schwab, 2017). This relationship is fostered by the integration of smart devices and sensors, enabling the collection and exchange of data, and ultimately driving enhanced connectivity and efficiency in numerous domains.

Table 2.1: Status of Using IoT in the TH Industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Internet of Things (IoT)	Yes	F	17	8	6	31
		%	48.57%	22.86%	17.14%	88.57%
	No	F	2	1	1	4
		%	5.71%	2.86%	2.86%	11.43%

According to Table 2.1, a significant majority of stakeholders in the TH industry, comprising 88.57 percent in total, utilize IoT technology. This includes 48.57 percent from the hotel sector, 22.86 percent from various destinations, and 17.14 percent from resorts. The application of IoT extends to various aspects of their operations, such as security surveillance, marketing campaigns, self-control of room environments through smart transport systems, improvement of customer services and assistance, monitoring occupancy, Wi-Fi control, order processing, and comprehensive hotel monitoring.

2.2 Status of Using Big Data Analysis in the TH Industry of Bangladesh

Big Data encompasses the concept of handling extensive and intricate datasets that cannot be effectively managed, processed, and analyzed using traditional data processing methods. Scholars and experts have presented diverse definitions of Big Data, capturing its distinct characteristics and implications. Chen et al., (2012) propose the "three Vs" as defining features of Big Data: volume, velocity, and variety. This definition highlights the massive scale of data, the high speed of data generation and processing, and the heterogeneous nature of data types and sources. Gandomi and Haider (2015) introduce two additional dimensions to Big Data: veracity and value. Veracity refers to the reliability and accuracy of data, while value emphasizes the potential insights and benefits that can be derived from Big Data. Manyika et al., (2011) adopt a perspective that emphasizes the value-creation potential of Big Data through data-driven decision-making. They underline the importance of applying advanced analytics techniques to extract meaningful insights from large datasets, resulting in enhanced performance and innovation.

Table 2.2: Status of Using Big Data Analysis in the TH Industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Big Data Analytics	Yes	F	14	6	4	24
		%	40.00%	17.14%	11.43%	68.57%

	No	F	5	3	3	11
		%	14.29%	8.57%	8.57%	31.43%

As depicted in Table 2.2, a substantial portion of the tourism and hospitality practitioners in Bangladesh, amounting to 68.57 percent, actively employ big data analysis. This group comprises 40 percent from the hotel sector, 17.14 percent from various destinations, and 11.43 percent from resorts. Their utilization of big data analysis encompasses various key functions, including the analysis of marketing campaigns, the collection, and assessment of guest comments and experiences, feedback review, customer needs analysis, enhancement of tourist satisfaction, innovation in product development, identification of market trends, formulation of pricing strategies, and exploration of new opportunities.

2.3 Status of Using 3D Printing in the TH Industry of Bangladesh

3D printing, also known as additive manufacturing, is a manufacturing process that creates three-dimensional objects from a digital model by adding material layer by layer. Unlike traditional subtractive manufacturing methods that involve cutting or shaping material from a solid block, 3D printing builds objects by depositing material, typically in the form of plastic, metal, or resin, in a sequential and precise manner.

Table 2.3: Status of Using 3D Printing in the TH Industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
3D Printing	Yes	F	11	1	0	12
		%	31.43%	2.86%	0.00%	34.29%
	No	F	8	8	7	23
		%	22.86%	22.86%	20.00%	65.71%

As shown in Table 2.3, the majority of stakeholders in this industry, specifically 65.71 percent, do not utilize 3D printing technology, while only 34.29 percent make use of it. Notably, the data also indicates that no resorts in the country have adopted 3D printing to visualize their properties. Additionally, among the hotels, 31.43 percent incorporate 3D printing for various purposes, including marketing initiatives, providing unique services, offering visual hotel overviews, advertising, and presenting culinary offerings.

2.4 Status of Using Autonomous Robots in the TH Industry of Bangladesh

Corke (2017) defines autonomous robots as machines capable of performing tasks and making decisions without direct human control. These robots are equipped with sensors, perception capabilities, and onboard intelligence that enable them to navigate their environment, interact with objects, and adapt their behavior based on changing circumstances. Siciliano and Khatib (2016) describe autonomous robots as robotic systems that possess the ability to sense, reason, and act in response to their environment

autonomously. These robots leverage advanced algorithms, sensor fusion techniques, and decision-making mechanisms to perform complex tasks without continuous human intervention. Kortenkamp et al., (2013) define autonomous robots as intelligent machines capable of operating independently to accomplish specific goals. These robots utilize artificial intelligence techniques, such as machine learning and planning algorithms, to perceive their environment, make decisions, and execute actions without relying on constant human guidance.

Table 2.4: Status of Using Autonomous Robots in the TH Industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Autonomous Robots	Yes	F	2	0	0	2
		%	5.71%	0.00%	0.00%	5.71%
	No	F	17	9	7	33
		%	48.57%	25.71%	20.00%	94.29%

It is found that only 5.71 percent of hotels in Bangladesh use Autonomous Robots in the TH industry (table 2.4).

2.5. Status of Using Artificial Intelligence (AI) in TH Industry of Bangladesh

Russell and Norvig (2016) define Artificial Intelligence as the field of study and development of intelligent agents that can perceive their environment, reason about it, and take actions to achieve specific goals. AI involves the simulation of human intelligence in machines, enabling them to perform tasks that typically require human intelligence, such as problem-solving, decision-making, and learning. McCarthy et al. (1955) introduced the term "Artificial Intelligence" and defined it as the science and engineering of making intelligent machines. They focused on the development of machines that can mimic and replicate human intelligence, including the ability to understand natural language, reason, learn, and adapt. Nilsson (1998) describes AI as the study of how to make computers perform tasks that require human intelligence. This includes areas such as knowledge representation, problem-solving, perception, learning, and planning. The goal of AI is to create machines that can exhibit intelligent behavior and adapt to different situations. Luger (2019) defines AI as the capability of a machine to imitate intelligent human behavior. This involves the use of algorithms and computational models to enable machines to process information, learn from data, and make decisions or take actions based on that knowledge.

Table 2.5: Status of Using AI in the TH Industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Artificial	Yes	F	4	0	2	6

Intelligence (AI)		%	11.43%	0.00%	5.71%	17.14%
	No	F	15	9	5	29
		%	42.86%	25.71%	14.29%	82.86%

The findings of this study indicate that AI is utilized by 17.14 percent of TH practitioners, with 11.43 percent representing the hotel sector and 5.71 percent representing resorts. Its applications encompass security purposes, including face recognition systems and transactions via Visa cards, Mastercard, and ATM (Automated Teller Machine), as detailed in Table 2.5.

2.6 Status of Using Virtual Reality (VR) in the TH Industry of Bangladesh

Sherman and Craig (2003) define Virtual Reality as a computer-generated simulation that immerses users in a three-dimensional environment, allowing them to interact with and experience a virtual world. VR typically involves the use of head-mounted displays, haptic devices, and motion-tracking systems to create a sense of presence and realism. Steuer (1992) describes Virtual Reality as a communication medium that presents users with a computer-generated environment, simulating a physical presence and enabling user interaction. VR aims to create a compelling and immersive experience that engages the user's senses and perception. Slater and Wilbur (1997) define Virtual Reality as a technology that enables users to experience computer-generated environments that can be similar to or different from the real world. VR provides a sense of presence and allows users to interact with the virtual environment in real time.

Table 2.6: Status of Using Virtual Reality (VR) in the TH Industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Virtual Reality (VR)	Yes	F	10	3	3	16
		%	28.57%	8.57%	8.57%	45.71%
	No	F	9	6	4	19
		%	25.71%	17.14%	11.43%	54.29%

Table 2.6 illustrates that 45.71 percent of TH stakeholders, consisting of 28.57 percent from the hotel sector, 8.57 percent from destinations, and 8.57 percent from resorts, employ virtual reality technology. They use it for purposes such as providing potential guests with visualizations of hotel rooms, creating 3D movie experiences, and establishing gaming centers.

2.7 Status of Using Augmented Reality (AR) in TH Industry of Bangladesh

Azuma (1997) defines Augmented Reality as a technology that combines computer-generated virtual elements with the real world, creating an interactive and immersive experience. AR overlays digital information, such as images, videos, or 3D models, onto the user’s perception

of the physical environment. Billinghurst and Kato (2002) define Augmented Reality as a technology that enhances a user's perception and interaction with the real world through the seamless integration of virtual objects. AR systems use computer vision, tracking, and display technologies to overlay digital information onto the user's view. Azuma et al. (2001) describe Augmented Reality as a technology that supplements the real world with computer-generated information, enhancing the user's perception and understanding of the environment. AR provides real-time contextually relevant information that is aligned with the user's viewpoint. Fuchs et al. (2010) define Augmented Reality as an interactive technology that enhances the real world with virtual elements, enabling users to perceive and manipulate digital content within their physical environment. AR systems blend virtual objects with the real world in real time.

Table 2.7: Status of Using Augmented Reality (AR) in the TH Industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Augmented Reality (AR)	Yes	F	4	0	0	4
		%	11.43%	0.00%	0.00%	11.43%
	No	F	15	9	7	31
		%	42.86%	25.71%	20.00%	88.57%

According to Table 2.7, the use of augmented reality (AR) in hotels in Bangladesh is limited, with only 11.43 percent of hotels employing AR technology. Notably, the majority, comprising 88.57 percent of TH practitioners in the country, have not yet adopted AR.

2.8 Status of using Cloud Computing in the TH Industry of Bangladesh

Cloud computing is a technology model that allows access to a shared pool of computing resources, including servers, storage, networking, applications, and services, over the internet. These resources are provided and managed by cloud service providers, enabling users to scale up or down as needed and pay only for the resources they consume. Cloud computing offers flexibility, cost-efficiency, and accessibility, making it a fundamental component of modern IT infrastructure.

Table 2.8: Status of using Cloud Computing in the TH industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Cloud Computing	Yes	F	10	3	5	18
		%	28.57%	8.57%	14.29%	51.43%
	No	F	9	6	2	17

		%	25.71%	17.14%	5.71%	48.57%

Table 2.8 reveals that a total of 51.43 percent of TH stakeholders utilize cloud computing, comprising 28.57 percent from the hotel sector, 8.57 percent from destinations, and 14.29 percent from resorts. They employ cloud computing for various purposes, including generating occupancy reports, processing orders, handling room bookings, controlling functions, and monitoring via CCTV.

2.9 Status of using Biotechnology in the TH industry of Bangladesh

Biotechnology is a rapidly evolving field that encompasses the application of biological systems, organisms, or their components to develop technological applications and practical solutions. Extensive research has been conducted to define and explore the scope of biotechnology. Webster (2014) describes biotechnology as the application of scientific and engineering principles to manipulate biological materials for practical purposes. This multidisciplinary field incorporates various techniques, such as genetic engineering, molecular biology, and bioinformatics, to advance research and development. The European Federation of Biotechnology (2021) defines biotechnology as the integration of natural sciences and engineering principles to drive innovation. By manipulating living organisms or biological systems, biotechnology aims to create sustainable advancements in products, processes, and services across industries.

Table 2.9: Status of using Biotechnology in the TH industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Biotechnology	Yes	F	16	4	6	26
		%	45.71%	11.43%	17.14%	74.29%
	No	F	3	5	1	9
		%	8.57%	14.29%	2.86%	25.71%

According to Table 2.9, a significant majority, totaling 74.29 percent, of stakeholders in the tourism and hospitality sector in this country employ biotechnology. They utilize biotechnology for various purposes, including enhancing security through features such as fingerprint and face recognition, as well as controlling entry and exit in hotels.

2.10 Status of Using Blockchain Technology in the TH Industry of Bangladesh

Blockchain technology has gained significant attention due to its potential applications in various industries. Extensive research has been conducted to define and explore the core characteristics of blockchain technology. Tapscott and Tapscott (2016) describe blockchain as a digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value. It is a transparent and tamper-proof

system where transactions are verified by multiple participants in a network, eliminating the need for intermediaries. Zheng et al., (2018) define blockchain as a distributed ledger technology that employs consensus mechanisms, cryptographic techniques, and smart contracts to ensure secure and reliable recording, validation, and execution of transactions. It provides a decentralized and auditable record of transactions, promoting trust, transparency, and traceability in various industries.

Table 2.10: Status of Using Blockchain Technology in the TH Industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Blockchain technology	Yes	F	9	3	0	12
		%	25.71%	8.57%	0.00%	34.29%
	No	F	10	6	7	23
		%	28.57%	17.14%	20.00%	65.71%

The study reveals that in Bangladesh, 34.29 percent of hotels and destinations are utilizing blockchain technology. They employ this technology to enhance the security of guest information and financial transactions.

2.11 Status of using Nanotechnology in the TH Industry of Bangladesh

Nanotechnology is a multidisciplinary field of science, engineering, and technology that focuses on manipulating matter at the nanoscale. The nanoscale typically refers to structures, materials, and devices with dimensions in the range of 1 to 100 nanometers, where one nanometer is equal to one billionth of a meter. At this incredibly small scale, the properties of materials can differ significantly from their macroscopic counterparts due to quantum effects and increased surface area-to-volume ratios. Nanotechnology involves designing, fabricating, and manipulating nanoscale materials and structures to create new properties, functions, and applications.

Table 2.11: Status of using Nanotechnology in the TH industry of Bangladesh

Type of DIT	Using Status		Working Area of the Respondents			Total
			Hotel	Destination	Resort	
Nanotechnology	Yes	F	2	2	0	4
		%	5.71%	5.71%	0.00%	11.43%
	No	F	17	7	7	31
		%	48.57%	20.00%	20.00%	88.57%

The findings indicate that, in this country, only 11.43 percent of hotels and destinations are utilizing nanotechnology, specifically for GPS tracking systems (Table 2.11).

3.0 Industry 4.0: Challenges of Tourism and Hospitality Industry

The application of smart technology has brought about fundamental changes in the management of the industry as well as the behavior and needs of tourists (Wang et al., 2016). Metaverse unquestionably helped Generation Z create transformative experiences for tourism and heritage sites (Buhalis and Karatay, 2022, January).

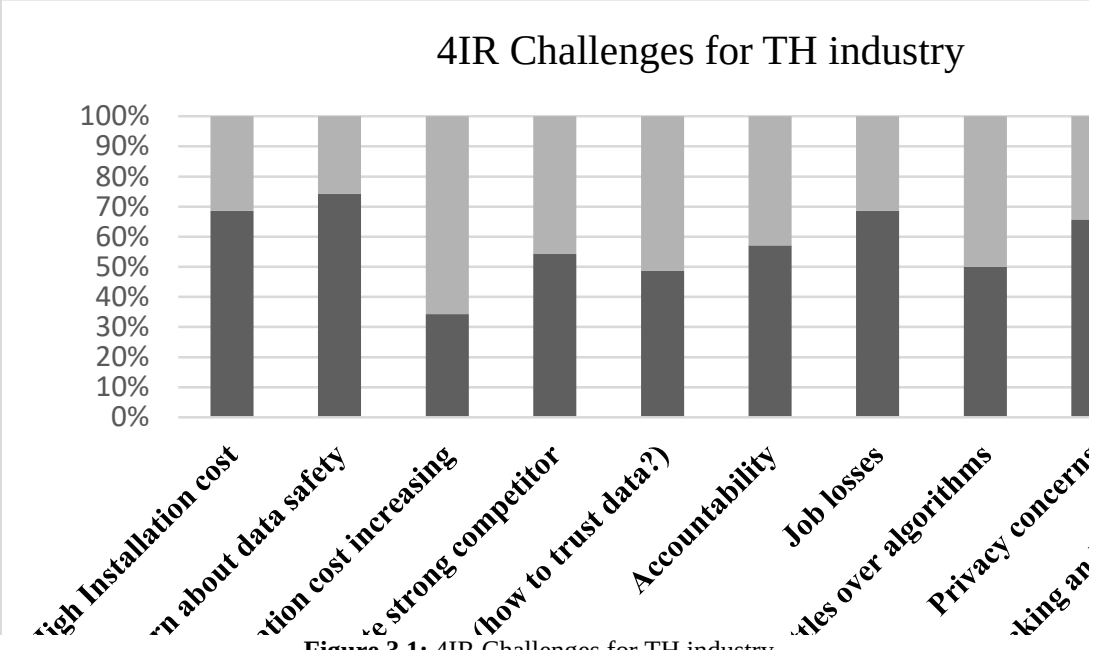

Figure 3.1: 4IR Challenges for TH industry

Although Gursoy et al. (2022) believed that the metaverse would not replace the true experience of hospitality and tourism, it would certainly change the way consumers consume hospitality and tourism products and services. The tourism industry is currently confronted with a range of challenges in the context of the Fourth Industrial Revolution, which refers to the integration of advanced technologies into various sectors. These challenges arise from both the opportunities and disruptions brought about by the rapid advancement of technology. Figure 3.1 shows the overwise of the 4IR's challenges in the TH industry. The next part of this chapter discusses the major challenges fetched by the TH industry for the 4IR.

3.1 High-Level Challenges

Table 3.1 categorically assesses the challenges, determines their levels, and identifies concerns about data safety, high installation costs, job losses, privacy concerns, and hacking and cyber risks as high-level challenges for the tourism and hospitality industry. Researchers believe that if the perceptual value for any item exceeds 65, it will be considered a high-level challenge.

3.2 Mid-level Challenges

Table 3.1 reveals that accountability, the creation of strong competitors, and establishing trust (particularly, addressing the challenge of how to trust data) are categorized as mid-level challenges for the TH industry within the context of the 4IR. Researchers consider any item with a perceptual value falling between 35 and 65 to be classified as a mid-level challenge.

Table 3.1: 4IR Challenges in the TH industry of Bangladesh

Level of Challenges	Challenges	Think as a challenge for the TH industry	Don't think as a challenge for the TH Industry
High-level challenges	Concern about data safety	74.3	25.7
	High Installation cost	68.6	31.4
	Job losses	68.6	31.4
	Privacy concerns	65.7	34.3
	Hacking and cyber risk	65.7	34.3
Mid-level Challenges	Accountability	57.1	42.9
	Create strong competitor	54.3	45.7
	Trust (how to trust data?)	48.6	51.4
Low-level Challenges	Adaptation cost increasing	34.3	65.7
	Battles over algorithms	25.7	25.7
	Others	17.1	82.9

3.3 Low-Level Challenges

Adaptation cost increases, battles over algorithms, and several other underlying challenges are categorized as low-level challenges, with their perceptual value being 35 or less (Table 3.1).

This study, based on the review, uncovers several significant challenges encountered by the tourism industry in the era of the 4IR.

3.4 Predict the Changing Customer Behavior

The emergence of real-time decision-making presents a significant challenge for the 4IR in the tourism industry (Tien, 2020). The 4IR has had a profound impact on customer behavior within the hotel industry, where customers now demand seamless digital experiences, mobile booking capabilities, and personalized services (Xiang et al., 2017). As a result, hotels must adapt to these shifting preferences and harness technology to fulfill customer expectations. Furthermore, the 4IR has empowered consumers by granting them access to extensive information, personalized recommendations, and instant booking options. Tourists, too, anticipate seamless digital experiences, tailored suggestions, and immediate assistance. To meet these evolving expectations, investments in technology and innovation are imperative

(Neuhofer et al., 2015). Advancements in technology have raised customer expectations for personalized experiences. In response, hotels must leverage data analytics, artificial intelligence, and machine learning to comprehend customer preferences and provide bespoke services. Achieving these goals necessitates substantial investments in technology and effective data management (Sigala, 2017).

3.5 Adopt Digital Disruption

The advent of digital platforms, online travel agencies, and sharing economy models has disrupted traditional tourism businesses such as travel agencies and hotels. The industry needs to adapt to changing consumer behavior and find ways to leverage digital technologies to remain competitive (Buhalis & Amaranggana, 2015). The rise of online travel agencies (OTAs), such as Booking.com and Expedia, has disrupted traditional hotel distribution channels. Hotels face challenges in maintaining control over pricing, managing customer relationships, and reducing dependency on OTAs (Gretzel & Yoo, 2008).

3.6 Technological Infrastructure

The Fourth Industrial Revolution relies heavily on advanced technological infrastructure, such as high-speed internet connectivity, mobile networks, and reliable power supply. In many destinations, especially in developing regions, the lack of adequate technological infrastructure can hinder the adoption and integration of advanced technologies in the tourism industry (Buhalis & Leung, 2018; Sigala, 2020a).

3.7 Integration of Emerging Technologies

The Fourth Industrial Revolution introduces a range of emerging technologies, such as artificial intelligence, virtual reality, and robotics. Hotels need to explore the integration of these technologies into their operations and guest experiences while ensuring seamless integration and providing value to customers (Ivanov et al., 2017).

3.8 Integration and Collaboration

Embracing the Fourth Industrial Revolution often requires collaboration and integration among various stakeholders, including tourism businesses, technology providers, government agencies, and local communities. Achieving seamless integration and collaboration can be challenging, especially in complex tourism ecosystems involving multiple players and interests (UNWTO-United Nations World Tourism Organization, 2019).

3.9 Challenges of Overcoming the Digital Divide

Prasetyo et al., (2020, August) identified the gap between the capabilities of local communities to access the knowledge of information technology and the widespread demand for the use of this technology. The 4IR has the potential to exacerbate the digital divide, where certain populations or regions have limited access to technology and digital resources. This can create inequalities in terms of access to information, online booking platforms, and

other digital services, impacting the ability of tourism businesses to reach and cater to all potential customers (Sigala, 2020b).

3.10 Workforce Adaptation and Upskilling

Kecić (2019) argued that jobs will evolve and technology will have a foremost impact on the hotel industry even though these jobs are highly dependent on people's soft skills. It, therefore, calls for a shift in focus from professions to work practices and placing a higher focus on individuals, skill sets, and ensuring their proper use. Kergroach (2017) notes that Industry 4.0 is changing the structure of the labor market, potential skill requirements, and new policy challenges. New workers facing the world of work 4IR must have new skills in automation, digital, and information technology, without overlooking soft skills (Petrillo *et al*., 2018). As technology automates certain tasks and processes, the tourism industry needs to address the impact on employment and workforce skills. The industry must invest in upskilling and reskilling programs to equip workers with the digital skills required in the 4IR (Sigala, 2020b). As technology advances, hotels face the challenge of ensuring their workforce is equipped with the necessary digital skills. This includes training employees to effectively use emerging technologies, managing automated systems, and leveraging data analytics for better decision-making (Azevedo & Pereira, 2020).

3.11 Adaption with Changing Marketing and Distribution Channels

The digital revolution has transformed marketing and distribution channels for hotels. Hotels face the challenge of effectively utilizing online platforms, social media, and digital marketing strategies to reach and engage customers in a highly competitive landscape (Inversini & Masiero, 2014).

3.12 Cybersecurity and Data Protection

With the increased use of digital technologies, the tourism industry must address concerns related to data privacy and security. Gathering and processing large amounts of customer data necessitates robust data protection measures to maintain customer trust (Gretzel et al., 2015). 4IR has heightened the importance of cyber security in the hotel industry. Hotels handle large amounts of sensitive customer data, and ensuring data protection is crucial for maintaining customer trust and complying with regulations like GDPR (Benitez et al., 2019). With the increasing reliance on technology and digital systems, the tourism industry faces the challenge of protecting against cyber threats and attacks. This includes safeguarding customer data, financial transactions, and critical systems from unauthorized access, hacking, and data breaches (Xiang et al., 2017). The 4IR has raised concerns about privacy and data ethics. Hotels handle vast amounts of guest data, and protecting customer privacy while ensuring ethical use of data is essential for maintaining trust and complying with privacy regulations (Law et al., 2014).

3.13 Regulation and Policy Frameworks

The Fourth Industrial Revolution introduced new and complex technologies that may require updated or new regulations and policy frameworks. The tourism industry needs clear

guidelines and regulations to navigate the ethical, legal, and social implications of emerging technologies such as artificial intelligence, blockchain, and virtual reality (Sigala & Gretzel, 2019).

3.14 Sustainable Tourism Development

According to UNWTO (United Nations World Tourism Organization). (2019) it is mentioned that while technology offers opportunities to enhance sustainability in the tourism industry, it also presents challenges. The industry must ensure that technological advancements are aligned with sustainable practices, minimize environmental impact, and support local communities.

3.15 Sustainable Practices and Environmental Impact

The Fourth Industrial Revolution provides opportunities for hotels to adopt sustainable practices and reduce their environmental footprint. However, integrating new technologies while maintaining sustainable operations presents challenges related to energy consumption, waste management, and resource efficiency. (Font & Harris, 2018).

Finally, these challenges underscore the need for the tourism industry to embrace digital transformation while addressing the social, environmental, and economic implications of the Fourth Industrial Revolution. Addressing these challenges will require a holistic approach, involving technological investments, policy frameworks, infrastructure development, and collaborative efforts among stakeholders's further research and ongoing adaptation to these challenges will be critical for the industry's long-term success.

4.0 Industry 4.0: Opportunities of Tourism and Hospitality Industry

The TH industry is one of the unsurpassed industries that has embraced technological developments associated with previous industrial revolutions such as the 4IR (Osei et al., 2020). The Fourth Industrial Revolution (4IR) presents numerous opportunities for the tourism and hospitality industry to leverage advanced technologies.

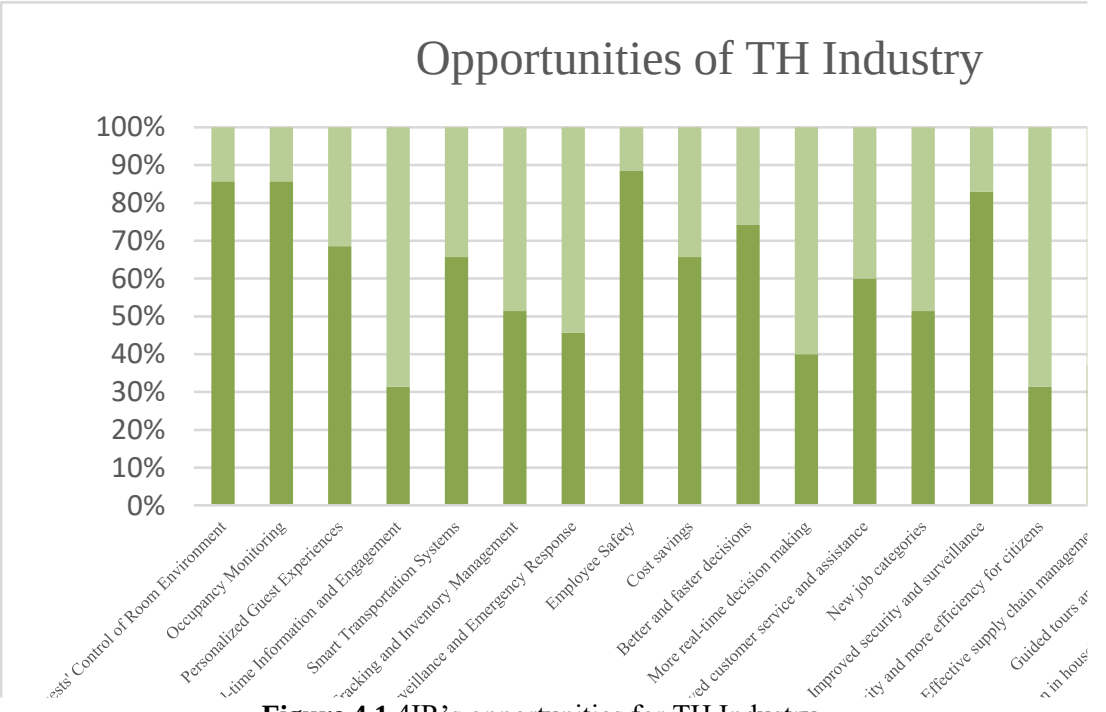

Figure 4.1 4IR's opportunities for TH Industry

Figure 4.1 shows the overview of 4IR's opportunities for the TH industry of Bangladesh. Here, the dark color displays the high-level perception of the people that the items create more opportunities for the TH industry of this country. The study explores the opportunity of 4IR in the TH industry of Bangladesh. Those are discussed below:

4.1 High-Level Opportunity

The study reveals employee safety, guests' control of room environment, occupancy monitoring, improved security and surveillance, better and faster decisions, personalized guest experiences, cooperation in housekeeping and maintenance, smart transportation systems, and cost savings as the high-level opportunities of 4IR in TH industry of Bangladesh (table 4.1). Researchers think that where the perceptual value is more than 65 for any item, it will be considered a high-level opportunity.

Table 4.1: Opportunities of 4IR in the TH industry of Bangladesh

Level of Opportunity	List of Opportunities	Think as an opportunity for 4IR	Don't think as an opportunity for 4IR
High-Level Opportunity	Employee Safety	88.6	11.4
	Guests' Control of Room Environment	85.7	14.3
	Occupancy Monitoring	85.7	14.3
	Improved security and surveillance	82.9	17.1

	Better and faster decisions	74.3	25.7
	Personalized Guest Experiences	68.6	31.4
	Cooperation in housekeeping and maintenance	68.6	31.4
	Smart Transportation Systems	65.7	34.3
	Cost savings	65.7	34.3
Mid-Level Opportunity	Improved customer service and assistance	60.0	40.0
	Asset Tracking and Inventory Management	51.4	48.6
	New job categories	51.4	48.6
	Surveillance and Emergency Response	45.7	54.3
	More real-time decision-making	40.0	60.0
	Effective supply chain management	37.1	62.9
Low-Level Opportunity	Real-time Information and Engagement	31.4	68.6
	Reduced complexity and more efficiency for citizens	31.4	68.6
	Guided tours and information	31.4	68.6
	More access to raw materials	28.6	71.4
	Others	25.7	74.3

4.2 Mid-Level Opportunity

Table 4.1 identifies improved customer service and assistance, asset tracking and inventory management, new job categories, surveillance and emergency response, more real-time decision-making, and effective supply chain management as mid-level opportunities.

4.3 Low-Level Opportunity

Real-time information and engagement, reduced complexity and more efficiency for citizens, guided tours and information, more access to raw materials, and some other unfolded items are considered low-level opportunities for the TH industry. The researcher thinks that where a perceptual value exists between 35 and 65 for any item, it will be considered as the mid-level opportunity, and their perceptual value is 35 or less.

Based on the content analysis of this study reveals some key areas where the industry can benefit from 4IR technologies. Those are discussed below:

4.4 Guest Services and Operational Efficiency

The implementation of AI-powered chat bots and virtual assistants can enhance the overall guest experience by providing instant customer support and personalized recommendations. AI can handle routine inquiries, offer concierge services, and even provide language translation services to cater to diverse customer needs (Gretzel & Fesenmaier, 2010). Automation technologies such as robotic process automation (RPA) and the IoT can

streamline operational processes, improve efficiency, and reduce costs. Hotels can automate tasks like check-ins, housekeeping, inventory management, and energy consumption, allowing staff to focus on delivering enhanced guest experiences (Buhalis & Leung, 2018). IoT devices and sensors can enable smart hotel operations, improving guest comfort and operational efficiency. Connected devices can monitor and control lighting, temperature, and security systems in rooms, while also facilitating personalized services such as customized room preferences and automated billing (Zhang et al., 2018). The use of robots in the hospitality industry can streamline service delivery and improve operational efficiency. Robots can perform tasks such as luggage handling, room service, and concierge services, freeing up staff to focus on providing personalized guest experiences (Ivanov et al., 2017b). Bhat (2020) identified that many hotels and destinations in India are using augmented reality to engage tourists in real-life experiences through multimedia tools. Mobile technology plays a vital role in the Fourth Industrial Revolution, offering opportunities for hotels to enhance the guest experience. Hotels can develop mobile apps that provide seamless check-in and check-out processes, keyless entry, real-time communication with staff, and access to personalized recommendations and services (Gretzel et al., 2015). Hotels in South Africa and Kenya have experienced a sharp increase in web-based bookings, and this requires new tech-savvy talent to cut costs, which was previously employed at the expense of preferred third-party tourism executives (Fwaya and Kesa, 2018). Bhat (2020) identified different emerging trends regarding the TH industry in India for 4IR. Firstly, robotic process automation is progressively being accepted as a tool for business travel management in 24x7 booking processes. Secondly, the AI-based guest system is being deployed to provide a personalized experience to customers by getting real-time information based on their tastes or usage.

4.5 Enhanced Guest Experience

4IR technologies offer opportunities to provide personalized and immersive guest experiences. Hotels can utilize augmented reality (AR) and virtual reality (VR) to offer virtual tours, interactive displays, and customized content, allowing guests to preview their stay and explore destinations (Sigala & Gretzel, 2019). Virtual and augmented reality technologies offer immersive experiences for tourists. Hotels can utilize these technologies to showcase their properties, provide virtual tours of destinations, or offer interactive experiences that enhance guest engagement and understanding of the local culture and attractions (Sigala & Gretzel, 2019). It also enables hotels to offer hyper-personalized experiences to guests by leveraging advanced data analytics and AI. By analyzing guest preferences, behaviors, and historical data, hotels can create customized offers, recommendations, and services tailored to individual guests, fostering a deeper level of personalization (Xiang et al., 2017). The vast amount of data available in the 4IR enables hotels to gain valuable customer insights. Hotels can use data analytics to understand guest preferences, behavior patterns, and trends, enabling them to make informed decisions, create targeted marketing campaigns, and develop personalized experiences that align with customer needs (Gretzel & Yoo, 2008). Buhalis and Karatay (2022, January) revealed that cultural heritage sites should consider using mixed reality to improve the consumer experience.

Especially for cities facing the emerging issues of a negative perception of tourism by residents, the Smart Tourism City concept can be a solution that will create extraordinary urban spaces for residents and visitors to enjoy (Lee et al., 2020). Mgiba and Chiliya (2020) found positive correlations between 4IR and online reputation and pre-visit experience. These, in turn, have an encouraging outcome on the intent to visit the area, as well as tourists' feelings of satisfaction after actually visiting the destination. Essentially, customization has been widely enabled with the advancement of real-time decision-making, IoT, AI mobile networks, and other advanced digital machinery (Tien, 2020).

4.6 Revenue and Asset Management

Advanced data analytics and revenue management systems can enable hotels to optimize pricing strategies and maximize revenue. By analyzing historical and real-time data on market demand, competitor rates, and customer behavior, hotels can dynamically adjust prices, offer personalized promotions, and improve revenue performance (Ivanov et al., 2018). It also enables hotels to implement predictive maintenance and asset management systems. IoT sensors and data analytics can monitor equipment performance, detect anomalies, and predict maintenance needs, allowing hotels to proactively address issues, minimize downtime, and optimize operational efficiency (Buhalis & Leung, 2018).

4.7 Marketing Applications

The more labor-intensive door-to-door promotion is increasingly being replaced by online-based marketing (Fwaya and Kesa, 2018). The advent of digital platforms and social media enables hotels to reach a broader audience and target specific market segments. Hotels can leverage data analytics, AI, and machine learning to analyze customer behavior, personalize marketing campaigns, and optimize pricing and distribution strategies (Xiang et al., 2017). 4IR enables hotels to leverage big data and AI algorithms to deliver highly targeted and personalized marketing campaigns. By analyzing customer preferences, behavior patterns, and social media data, hotels can offer tailored recommendations, promotions, and personalized experiences to individual guests (Xiang et al., 2017). Bhat (2020) identified that hospitality industry managers in India analyze big data collected from social media channels for targeted marketing of their products and services. Social media platforms provide a powerful tool for hotels to engage with customers and leverage user-generated content. Hotels can harness the power of social media by actively participating in conversations, responding to reviews and inquiries, and collaborating with influencers to reach a wider audience and enhance brand visibility (Gretzel & Fesenmaier, 2010).

4.8 Communications

Voice Recognition and Natural Language Processing: Voice recognition and natural language processing technologies can enhance guest interactions and enable seamless communication. Hotels can implement voice-controlled devices in rooms, allowing guests to control various amenities, request services, and access information through voice commands, improving convenience and satisfaction (Sigala & Chalkiti, 2018). The availability of large volumes of

data allows hotels to gain valuable insights into customer preferences, market trends, and operational performance. Applying predictive analytics to this data can help hotels make data-driven decisions, anticipate demand, optimize pricing, and personalized services (Gretzel & Yoo, 2008).

4.9 Sustainable and Green Technologies Practices

4IR technologies can support the implementation of sustainable practices in the tourism and hospitality industry. Smart energy management systems, IoT sensors, and AI-powered analytics can optimize energy consumption, reduce waste, and enhance resource efficiency in hotels (Gössling et al., 2019). It also provides opportunities for the tourism and hospitality industry to adopt sustainable and green technologies. These include renewable energy systems, smart energy management, waste reduction, and water conservation technologies, which can help hotels reduce their environmental footprint and meet the growing demand for sustainable tourism experiences (Gössling et al., 2019).

4.10 Data Security and Privacy

With the increased reliance on digital technologies, ensuring data security and privacy is crucial. Hotels can leverage cyber security measures, encryption techniques, and compliance with data protection regulations to protect guest information, maintain trust, and mitigate the risk of data breaches (Neuhofer et al., 2015b). The decentralized nature of blockchain technology can enhance security and transparency in financial transactions within the tourism and hospitality industry. Smart contracts based on blockchain can automate processes like booking confirmations, payments, and loyalty programs, reducing fraud and enhancing trust (Pavlou et al., 2017). In India, different companies are starting to use private blockchains to control internal processes and manage the distribution of hotel and restaurant supplies and other assets (Bhat, 2020).

4.11 Skills Development and Training

Technology and innovation have helped the tourism industry around the world, replacing expensive human labor with high-tech labor (Khan et al., 2021). As new technologies emerge, the industry needs a skilled workforce to adapt and effectively utilize them. Hotels can invest in training programs and partnerships with educational institutions to develop digital skills and competencies among their employees, ensuring they can leverage 4IR technologies to their fullest potential (Ioannides, 2018).

4.12 Smart Destination Management

4IR technologies can enable smart destination management, enhancing the overall visitor experience. Destination management organizations can leverage IoT, mobile apps, and data analytics to provide real-time information, interactive maps, and personalized recommendations to tourists, thereby improving their engagement and satisfaction (Gretzel et al., 2015). India is evolving as a favored destination for medical tourism as it offers

progressive services, expert doctors, and affordable treatment to overseas patients (Bhat, 2020).

4.13 Collaborative Consumption and Sharing Economy

The Fourth Industrial Revolution has facilitated the growth of collaborative consumption and sharing economy models, allowing individuals to rent or share accommodations, transportation, and experiences. Hotels can participate in this trend by partnering with sharing economy platforms or offering their sharing services to cater to changing consumer preferences (Guttentag, 2015).

4.14 Collaboration with Technology Startups

The 4IR has given rise to numerous technology startups that offer innovative solutions for the tourism and hospitality industry. Hotels can collaborate with these startups to leverage their expertise and technologies, fostering innovation and gaining a competitive edge (Hjalager & Ritter, 2018). The 4IR has driven the growth of the tourism industry, and many cities have built a smart tourism ecosystem based on the existing digital technology infrastructure of smart cities. Which makes tourism more competitive than ever (Lee et al., 2020).

Finally, it can be concluded that the TH industry is one of those industries that have always incorporated the technological advancement associated with the previous industrial revolutions (Osei et al., 2020). It has been identified that 4IR has huge prospects including financial benefits, the solution to cyclical employment, and labor turnover, functioning, and employee efficiency, supply chain efficiency, customer service quality, and enhancement of environmental sustainability and digitization of operations as well as the creation of new jobs (Gretzel et al., 2015; Buhalis and Amaranggana, 2015; Ivanov and Webster, 2017; Shamim et al., 2017; Kuo et al., 2017; Li et al., 2017; Huang et al., 2017; Vecchio et al., 2018; Lee et al., 2019). By embracing these additional opportunities, the tourism and hospitality industry can harness the power of the 4IR to deliver exceptional guest experiences, improve operational efficiency, and drive business growth.

5.0 Conclusion and Recommendations

The study reveals that currently, hotels, tourism destinations, and resorts in Bangladesh are embracing disruptive technologies associated with the 4IR. In Bangladesh, 34.29 percent of stakeholders in the TH sector utilize 3D printing, 5.71 percent employ autonomous robots, 17.14 percent harness artificial intelligence (AI), 45.71 percent leverage virtual reality (VR), and 11.43 percent make use of augmented reality (AR). Additionally, 51.43 percent implement cloud computing, while 74.29 percent employ biotechnology. Furthermore, it was discovered that a significant majority of TH stakeholders, specifically 88.57 percent, harness the power of IoT for a multitude of purposes. These include security surveillance, conducting marketing campaigns, managing room environments through smart transport systems, enhancing customer service, monitoring occupancy, controlling Wi-Fi access, facilitating order placement, and overseeing hotel operations as a whole. Moreover, in Bangladesh, 68.57

percent of professionals in the tourism and hospitality sector actively apply big data analysis techniques. They employ this approach for marketing campaigns, collecting guest feedback, conducting customer needs analysis, fostering innovation, identifying market trends, formulating pricing strategies, and exploring new opportunities. Cloud computing plays a pivotal role in generating occupancy reports, processing orders, facilitating room bookings, managing various functions, and overseeing CCTV surveillance within the TH industry.

In addition to these findings, the study delves into the challenges posed by the Fourth Industrial Revolution (4IR) in the TH industry of Bangladesh. These challenges are categorized into three levels. High-level challenges encompass concerns related to data safety, the high cost of technology installation, potential job displacement, privacy issues, hacking incidents, and cyber risks. Mid-level challenges involve considerations such as accountability, the emergence of strong competition, and the importance of trust. Low-level challenges revolve around increasing adaptation costs, disputes over algorithms, and various underlying issues.

Furthermore, the study highlights a range of opportunities that Industry 4.0 presents in the TH industry of Bangladesh. These opportunities are also divided into three groups. High-level opportunities include enhancing employee safety, granting guests control over their room environments, monitoring occupancy effectively, improving security and surveillance measures, expediting decision-making processes, personalizing guest experiences, facilitating collaboration in housekeeping and maintenance tasks, and implementing smart transportation systems to achieve cost savings. Mid-level opportunities entail enhancing customer service and support, tracking assets and managing inventory efficiently, creating new job categories, improving surveillance capabilities, streamlining emergency response procedures, enabling real-time decision-making, and optimizing supply chain management within the TH industry.

The study also emphasizes the importance of policymakers and practitioners taking into consideration both the identified challenges and opportunities when formulating future strategies for the industry.

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