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HOSPITALITY DIGITAL MARKETING AND TECHNOLOGY TRANSFORMATION CHALLENGES

Abstract: The subject of the paper is the importance of investment in the implementation of new technologies in the digital transformation of hotels within the marketing and business development objectives. For this paper, empirical research was conducted in over 30% of the total number of 4 and 5-star hotels in Serbia (41 hotels) in 2021 on the use of modern technologies in the digitalization of hotel business, related to the hotel characteristics. The implementation of cloud technology, energy management, automation, and technologies of sophisticated machine learning was considered. The difference in statistical significance was shown in the revenue level and investments of the hotels in the last three years in the technologies of sophisticated machine learning, which also affected the achieved level of digitalization of the aforementioned hospitality operations. Undoubtedly, it is a positive finding that hotels with a high and medium level of digitalization together make up over 80% of the surveyed hotels, which indicates a high level of awareness of hoteliers about the importance of digital technologies for customer relationship marketing and business development objectives, as well as broader sustainable development goals.

Keywords: marketing, tourism, business objectives, technology change

1. Introduction

The state and trends of the tourism market in which the hotel industry has a significant function are determined by the accelerated development of digital technologies (Tussyadiah, 2020). Digital technologies are enablers of digital transformation. Since the appearance of the Internet and World Wide Web and its adoption worldwide, an increasing number of technologies such as broadband, smartphones, social media, cloud technology, and online purchase systems have evolved and become commonplace in business. The ubiquity of big data (Lyu et al., 2022) and the development of technologies, such as the Internet of Things (Mercan et al.,

2020), machine learning (Calvo-Pasqual and Garrido-Merchan, 2021), robots, artificial intelligence, service automation (Ivanov & Webster, 2019) and blockchain applications (Ozdemir et al., 2020) becoming increasingly important in the hotel industry and the tourism sector (Samala et al., 2020).

Contemporary technologies can contribute to the hotel's business at all levels from strategic to operational (Law et al., 2014). Understanding, knowledge, investment in the implementation of digital technology solutions in the hotel industry, as well as the ability to evaluate, recommend and acquire knowledge about new solutions to improve operational efficiency, hotel productivity, and revenue, are becoming a prerequisite for

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increasing competitiveness, survival and profitability of this industry (Ristova & Maglovski, 2018). These technologies are related to (Stringam & Gerdes, 2021):

- Hotel operations: administrative/ back office and human resources technology, hotel engineering infrastructure, and operations technology, and

- Service experience for hotel guests: hardware and proprietary devices, and software (local or cloud-based) applications that provide or improve guest experience, improve guest comfort and satisfaction, and enable customer service and communication. More and more hoteliers are focusing on guest service technology and investing in it while underinvesting in guest engagement, acquisition, and retention technology (Cobanoglu et al., 2011; Vasadze et al., 2018; Yang et al., 2021).

The hotel industry in Serbia follows world trends. Investments in digitalization in the Serbian hotel industry take place in a specific innovative ecosystem, which is very prosperous in one part of the implementation of digital technologies, as well as in the development of the ICT sector, and on the other hand limiting (Savić et al., 2018). Therefore, it is important to take into account some of the following aspects of the ecosystem that affect hotel digitalization:

- ICT development and implementation, the ICT infrastructure level, use, adoption, and adaptation of digital technologies by hotels require sufficient ICT infrastructure. It is necessary to consider the prevalence of infrastructure and the possibility of access and the quality of infrastructure that allows for more advanced and efficient use.

- Research and development activity is needed not only for the production of digital technologies for hotels but also for their adoption because these technologies often require adaptation or modification for local use. The connections of the hotel industry with the economy and the state are working on technological innovations and development, state expenditures for these needs, implementation of digital knowledge, and outcomes of creative activities and services including tourism and supply chain sectors should be added to this (Miletić & Ćurčić, 2021).

- The industrial activity aims to include current activities in the industry related to the use, adoption, and adaptation of frontier technologies and shows innovations in the industry in the private sector, finance, and ICT, which seek to interact with other technologies. In addition, data on exports, high-tech manufacturers, as well as on digitally delivered services covering both finance and ICT are used.

- Access to finance assesses the availability of finance to the private sector, in general, and for technological transformation. Better access to finance could accelerate the use, adoption, and adaptation of frontier technologies.

The paper is based on the research of the literature and the data of the empirical research obtained by questionnaire survey with the owners and managers in 41 high category hotels in Serbia. Statistical methods, general scientific methods of analysis, and a theoretical framework of research were used (Domingos, 2015; Gravetter & Valnau, 2017). The main results of the research supported the importance of gaining a competitive advantage for hotel companies by applying contemporary technologies in their digital transformation.

The organization of the work is such that, after the introduction, the theoretical and hypothetical framework and empirical

research of the representatives' attitudes are presented and the calculation of the statistical significance of this transformation in the characteristics of individual hotels is given. The key results are discussed in the following section, together with their scientific and practical contributions, limitations, and new research to which they point. The conclusion with the used literature is given at the end of the paper

2. The theoretical framework of the research

With digital technologies, the competition is changing, becoming more global with increased intensity (Lubian & Esteves, 2017). The digital transformation and the resulting innovation of the business model have fundamentally changed the expectations and behaviors of consumers, putting enormous pressure on traditional organizations and disrupting numerous markets. Based on the existing literature, three phases of digital transformation can be identified: 1. digitization, 2. digitalization, and 3. digital transformation (Verhoef et al., 2021). Despite the ubiquity and visible impact of digital transformation and the resulting new digital business models, this topic has still received limited attention in the academic literature (Jafari-Sadeghi et al., 2021), so far approaching digital change within specific business disciplines, including:

- digital advertising in the framework of marketing research, social media, and networks, the development of multiple channels (Grewal et al., 2020),
- strategic management focused on the conceptualization, operationalization, and innovation of (digital) business models (Guggenberger et al., 2020; Comin et al., 2019),
- information systems, where attention is paid to the IT adoption and IS implementation and the

resulting business value (Jeyaraj & Zadeh, 2020).

Digital transformation is multidisciplinary, as it involves changes in strategy, organization, information technology, supply chains, marketing, etc. Digital transformation is also important for environmental sustainability, taking into account energy sustainability and resource transformation (Echchad, 2022). One comprehensive definition of digital transformation is given by Gong and Ribiere (2021) defining it as a fundamental change enabled by digital technologies aimed at bringing radical improvement and innovation to a company (or other entity), to create value for its stakeholders through the strategic use of main resources and capabilities. Digital transformation requires the company to create an appropriate strategy, make changes in its business model, clearly define the scope of transformation, and external and internal data sources, ensure consistency of strategic formulation and implementation, taking into account organizational and human issues, not just technological (Correani et al., 2020).

Technological enablers of digital transformation are numerous, including the expansion of the Internet, growth of mobile networks and smartphones, smart mobile devices, social media, social networks, Internet of Things, big data and analytics, cloud services, online purchase systems, machine learning, robots, artificial intelligence, automation and optimization, 3D printers, virtual reality, electronic identification, blockchain, energy-saving systems, etc. (Ko et al., 2019; Dexeus, 2019). Although each of these technologies may not be as powerful as expected, the widespread entry of new digital technologies into business indicates the need for companies to transform their business digitally. They can affect the cost structure of a company, and human resources through the use of robots or virtual agents, or by optimizing logistics flows and reducing supply chain costs using artificial intelligence and a supply chain block. In addition, digital technologies provide energy-saving opportunities

(Echchad, 2022). Building energy management systems use digital technologies to collect and analyze data, reduce costs, improve process effectiveness, foresee future consumption, and contribute to the environment (Vučković & Pitić, 2022).

While ICTs have been used in the hotel industry since the late 1970s in the form of computerized reservation and global distribution systems, it was not until the 1990s that ICTs began to have a significant impact on the industry. The impact of ICT on the infrastructure of the hotel industry has had significant strategic implications for the industry leaders. Rapid progress and commercialization of information and communication technology benefits have encouraged hotels and various tourism companies that are in the supply chain or tourist destination clusters to progressively adopt technological innovation (Stylos et al., 2021). It is important not only to follow the latest technological trends in the hotel industry, but also to keep up with the times,

because the industry is very competitive and hotels are aware of the dangers of not adapting to technological trends, especially encouraged by changes due to COVID, and beyond (Chen et al., 2021) because the expectations and requirements of the users are constantly changing.

By introducing new methods and technological solutions to digital-based businesses, hotels believe that they will help them improve their work efficiency and ability to meet customer needs and experience (Han et al., 2021). Technological advances can enable hotels to increase the level of customer comfort, to take care of their satisfaction with the variety of services, and their practicality and transparency. Also, hotels should take into account environmental issues and the local community (Demir et al., 2021). The digital transformation of the hotels should include all these activities as shown in Figure 1.
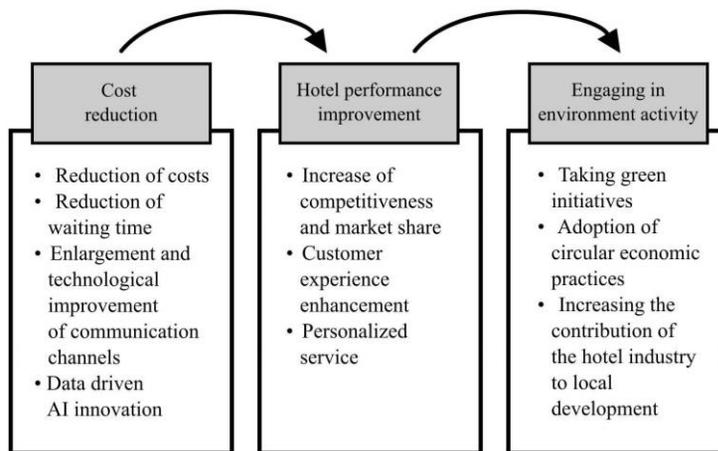
Figure 1. Advantages of digital business transformation in the hotel industry
Source: Authors

3. Methodology

To assess the stages of digital transformation of the organization, different concepts were developed, such as five stages in digital business transformation (Berghaus and Back,

2016), Forrester digital maturity model with four levels (Gill & VanBoskirk, 2016), MIT/Deloitte model with three levels of maturity (Kane et al., 2017). These models are general in nature. Many models have been developed that are domain specific, such as

models for a particular industry or sector, such as digital maturity model in manufacturing sector for industry 4.0 (Colli et al., 2018), digital maturity model for telecommunication service providers (Valdez-de-Leon, 2016) etc. Digital maturity models are very heterogeneous, differ in the level of complexity and components included in the model, and are limited by a lack of validation (Williams et al., 2019).

In this research on the level of digitalization in the hotel industry of Serbia, the following digital technologies were investigated: cloud technology; automation, process optimization, and interoperability of functions; energy management, and sophisticated machine learning algorithms. Their introduction into business operations of a hotel is estimated according to the hotel categorization, the level of revenue, and the level of the investment in business digitalization from the amount of income in a given period.

3.1. Sampling

The use of contemporary technologies in the hotel business and the process of their digitalization has been the subject of this research. A sample of 41 hotels in Serbia, mostly categorized as four- and five-star hotels, because it is assumed that hotels of these categories have the greatest interest in investing in the modernization of business, was used in the research in 2021. Empirical research of the attitudes of these hotels' representatives on the use of modern technologies in business in 2021 on the entire territory of Serbia was conducted using survey questionnaires. The following table (Table 1) shows the characteristics of the sample, frequency, and percentage of surveyed hotels by: category, legal form, income, and the position of hotel representatives who responded to the questionnaire.

Table 1. Sample Profile (Authors)

	Characteristics of the sample	**Count**	**Prob**
1.	**Respondents according to hotel function**		
1.1	Owner	5	0.12195
1.2	Manager/director	32	0.78049
1.3	Head of Department/IT Manager	4	0.09756
	Total	41	1.00000
2.	**Respondents according to hotel category**		
2.1	4 star	36	0.87805
2.1	5 star	5	0.12195
	Total	41	1.00000
3.	**Respondents according to the legal form of the hotel**		
3.1	Part of a foreign company, chain	3	0.07317
3.2	Mixed-capital companies	1	0.02439
3.3	Private independent company	37	0.90244
	Total	41	1.00000
4.	**Respondents according to income in 2021**		
4.1	Up to 70.000 euros	22	0.53659
4.2	From 70.001 to 150.000 euros	12	0.29268
4.3	From 150.001 to 2.000.000 euros	7	0.17073
	Total	41	1.00000

Forty-one hotels participated in the empirical research on the level of digitalization of hotels in Serbia. The most represented category is the 4-star category, namely 36 of them

(87.80% of the total number of hotels in the sample, or 31.03% of the total of 116 4-star hotels. The 5-star category is represented by 5 hotels (12.19%, or 50.00% of the total

number of hotels with 5 stars).

The most represented function of hotel representatives who participated in the empirical research is the manager/director with 32 respondents or 78.04% of a total of 41 respondents, followed by the owner, 12.19%, and the head of department/IT manager 4 or 9.75%, which is the proof of the respondent's competence in giving views and information about the hotels. 37 hotels are private independent companies or 90.24% of the total number, followed by mixed-capital companies 2.43%, and 7.31% are a part of a foreign hotel chain. The most represented hotels are those with revenue up to 70,000 euros 22 or 53.65% of the total 41 hotels (in 2021), and the least represented hotels are those with revenue from 150,001 to 2,000,000 euros - 7 or 17.07% of the total 41 hotels.

3.2. Analysis

The following tables give descriptive analyzes of hotel investments in the digitalization of their business and services in the period 2018-2021 (Table 2) and subjective respondents' assessment of the achieved level of digitalization of hotel business (Table 3).

Table 2. Hotel investments in digitalization of business in Serbia, 2021 (Authors)

1	Respondents according to the percentage of hotel investment in IT/digitalization (of total revenue in the last three years)	Count	Prob
1.1	Up to 10%	27	0.65854
1.2	From 11 to 30%	13	0.31707
1.3	Over 30%	1	0.02439
	Total	41	1.00000

According to the data from Table 2. most hotels, 65.85% of the total of 41 surveyed ones, invested up to 10% of total revenue in the digitalization of businesses and services; up to 30% of them, invested 31.70% and 2.43% of them invested more than 30%.

Table 3. Actual level of digitalization of hotel business (Authors)

1	Respondents' assessment of the achieved level of digitalization of hotel business	Count	Prob
1.1	Hotel is in the beginning phase of the contemporary technologies implementation	8	0.19512
1.2	The hotel is at a medium level of implementation (partially implemented new technologies)	29	0.70732
1.3	Advanced implementation of new technologies in the hotel	4	0.09756
	Total	41	1.00000

Assessing the total achieved level of digitalization of business and services in a hotel, the respondents pointed out that most hotels reached the middle level, namely 29 or 70.73% of the total 41 hotels in the sample. In addition, 9.75% of the total 41 respondents rate the achieved level of digitalization as high, and 19.51% of them estimate that they are at the beginning of the digitalization of business and services.

Table 4 shows the level of implementation of researched digital technologies (cloud technology; automation, process optimization, interoperability of functions; energy management, and algorithms of sophisticated machine learning) in hotel business.

Table 4. The level implementation of the type of researched digital technology (Authors)

	Implementation level of the digital technology in hotel business	Count	Prob
1.	**Cloud technology**		
1.1	Not implemented	12	0.29268
1.2	Partially implemented	24	0.58537
1.3	Fully implemented	5	0.12195
	Total	41	1.00000
2.	**Automatization, process optimization, interoperability of functions**		
2.1	Not implemented	5	0.12195
2.2	Partially implemented	31	0.75610
2.3	Fully implemented	5	0.12195
	Total	41	1.00000
3	**Energy management**		
	Not implemented	9	0.21951
	Partially implemented	22	0.53659
	Fully implemented	10	0.24390
	Total	41	1.00000
4	**Algorithms of sophisticated machine learning**		
	Not implemented	33	0.80488
	Partially implemented	5	0.12195
	Fully implemented	3	0.07317
	Total	41	1.00000

The assessment of the modern technologies implementation level: clouds, automation, energy management, and algorithms of machine learning based on these investments concerning the total achieved level of business digitalization is as follows:

- Cloud technology - 58.53% of the surveyed hotels partially apply this technology in their business, and 12.19% of them have fully applied it.
- Automation, process optimization, and interoperability of functions are partially implemented technology in the business of 75.61% of hotels and fully implemented in 12.19% of the hotels.
- Energy management is a partially implemented technology in 53.65% and fully implemented in 24.39% of the hotels.
- Sophisticated machine learning algorithms are partially implemented as technology in 12.19% and fully implemented in 7.31% of the hotels.

The implementation of these digital technologies in some of the surveyed hotels has not started as follows: algorithms of sophisticated machine learning in 80.48%, energy management in 21.95%, automation in 12.19%, and technology clouds at 29.26% of hotels. Over 80% of hotels are in the category of medium and advanced levels of digitalization, which is a statistically significant result. The following section provides a more detailed analysis of this significance.

Two hypotheses were set:

- H_0 = There is no statistically significant difference in the implementation of digital technologies concerning the defined characteristics of hotels: categorization, years of business, income, and hotel investment in digitalization.

- Ha = There is a statistically significant difference in the implementation of digital technologies to the defined characteristics of hotels: categorization, years of business, age, income, and hotel investment in digitalization.

The following tables show the level of implementation of researched digital technologies in the category of hotels (Table 5) and hypothesis testing (Table 6).

Table 5. Implementation level of digital technologies with the category of hotels (Authors)

Hotel category	Digital technology type											
	Cloud technology											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
4 stars	10	83.33%	27.78%	24.39%	22	91.67%	61.11%	53.66%	4	80.00%	11.11%	9.76%
5 stars	2	16.67%	40.00%	4.88%	2	8.33%	40.00%	4.88%	1	20.00%	20.00%	2.44%
	Automation, process optimization, interoperability of functions											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
4 stars	5	100.00%	13.89%	12.20%	28	90.32%	77.78%	68.29%	3	60.00%	8.33%	7.32%
5 stars	0	0.00%	0.00%	0.00%	3	9.68%	60.00%	7.32%	2	40.00%	40.00%	4.88%
	Energy management											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
4 stars	8	88.89%	22.22%	19.51%	19	86.36%	52.78%	46.34%	9	90.00%	25.00%	21.95%
5 stars	1	11.11%	20.00%	2.44%	3	13.64%	60.00%	7.32%	1	10.00%	20.00%	2.44%
	Sophisticated machine learning algorithms											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
4 stars	30	90.91%	83.33%	73.17%	4	80.00%	11.11%	9.76%	2	66.67%	5.56%	4.88%
5 stars	3	9.09%	60.00%	7.32%	1	20.00%	20.00%	2.44%	1	33.33%	20.00%	2.44%

Table 6. Hypothesis testing: hotel category/digital technology (Authors)

Hotel category By Cloud technology						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0 is accepted
Pearson	0.843	0.6561	2	5.991	0.05	
Hotel category By Automation, process optimization, interoperability of functions						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0 is accepted
Pearson	4.488	0.1060	2	5.991	0.05	
Hotel category By Energy management						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0 is accepted
Pearson	0.098	0.9524	2	5.991	0.05	
Hotel category By Sophisticated machine learning algorithms						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0

Hotel category By Cloud technology						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0
Pearson	0.843	0.6561	2	5.991	0.05	is accepted
Pearson	1.833	0.3999	2	5.991	0.05	is accepted

The following tables show the level of implementation of digital technologies for hotel revenues in 2021 (Table 7) and hypothesis testing (Table 8).

Table 7. Implementation level of digital technologies with the category of hotels (Authors)

Hotel revenue in 2020	Digital technology type											
	Cloud technology											
	at the beginning of the implementation				partially implemented				advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Up to 70,000€	6	50.00%	27.27%	14.63%	12	50.00%	54.55%	29.27%	4	80.00%	18.18%	9.76%
70,001-150,000€	5	41.67%	41.67%	12.20%	7	29.17%	58.33%	17.07%	0	0.00%	0.00%	0.00%
150,001-2,000,000€	1	8.33%	14.29%	2.44%	5	20.83%	71.43%	12.20%	1	20.00%	14.29%	2.44%
	Automation, process optimization, interoperability of functions											
	at the beginning of the implementation				partially implemented				advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Up to 70,000€	3	60.00%	13.64%	7.32%	18	58.06%	81.82%	43.90%	1	20.00%	4.55%	2.44%
70.001 to 150,000€	1	20.00%	8.33%	2.44%	10	32.26%	83.33%	24.39%	1	20.00%	8.33%	2.44%
150,001 to 2,000,000€	1	20.00%	14.29%	2.44%	3	9.68%	42.86%	7.32%	3	60.00%	42.86%	7.32%
	Energy management											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Up to 70,000€	4	44.44%	18.18%	9.76%	13	59.09%	59.09%	31.71%	5	50.00%	22.73%	12.20%
70,001-150,000€	4	44.44%	33.33%	9.76%	6	27.27%	50.00%	14.63%	2	20.00%	16.67%	4.88%
150,001-2.000,000	1	11.11%	14.29%	2.44%	3	13.64%	42.86%	7.32%	3	30.00%	42.86%	7.32%
	Sophisticated machine learning algorithms											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Up to 70,000€	20	60.61%	90.91%	48.78%	1	20.00%	4.55%	2.44%	1	33.33%	4.55%	2.44%
70,001-150,000€	10	30.30%	83.33%	24.39%	2	40.00%	16.67%	4.88%	0	0.00%	0.00%	0.00%
150,001 to 2,000,000€	3	9.09%	42.86%	7.32%	2	40.00%	28.57%	4.88%	2	66.67%	28.57%	4.88%

Table 8. Hypothesis testing: hotel revenue/digital technology (Authors)

Hotel revenue in 2020 By Cloud technology						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0
Pearson	3.591	0.4642	4	9.488	0.05	is accepted
Hotel revenue in 2020 By Automation, process optimization, interoperability of functions						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0
Pearson	8.008	0.0913	4	9.488	0.05	is accepted
Hotel revenue in 2020 By Energy management						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0
Pearson	2.638	0.6201	4	9.488	0.05	is accepted
Hotel revenue in 2020 By Sophisticated machine learning algorithms						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	**H_0 not accepted**
Pearson	9.763	0.0446	4	9.488	0.05	**Ha is accepted**

The following tables show the level of implementation of researched digital technologies about the percentage of investments from the total hotel revenue in the last three years in the digitalization of hotels (Table 11) and hypothesis testing (Table 12).

Table 9. Implementation level of digital technologies about the percentage of investments from the total hotel revenue in the last three years/digital technology (Authors)

% of hotel investing from total revenue in DTs	Digital technology type											
	Cloud technology											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Up to 10%	10	83.33%	37.04%	24.39%	14	58.33%	51.85%	34.15%	3	60.00%	11.11%	7.32%
11-30%	2	16.67%	15.38%	4.88%	9	37.50%	69.23%	21.95%	2	40.00%	15.38%	4.88%
Over 30%	0	0.00%	0.00%	0.00%	1	4.17%	100.00%	2.44%	0	0.00%	0.00%	0.00%
	Automation, process optimization, interoperability of functions											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Up to 10%	5	100.00%	18.52%	12.20%	21	67.74%	77.78%	51.22%	1	20.00%	3.70%	2.44%
11-30%	0	0.00%	0.00%	0.00%	9	29.03%	69.23%	21.95%	4	80.00%	30.77%	9.76%
Over 30%	0	0.00%	0.00%	0.00%	1	3.23%	100.00%	2.44%	0	0.00%	0.00%	0.00%
	Energy management											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Up to 10%	9	100.00%	33.33%	21.95%	11	50.00%	40.74%	26.83%	7	70.00%	25.93%	17.07%
11-30%	0	0.00%	0.00%	0.00%	10	45.45%	76.92%	24.39%	3	30.00%	23.08%	7.32%

% of hotel investing from total revenue in DTs	Digital technology type											
	Cloud technology											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Over 30%	0	0.00%	0.00%	0.00%	1	4.55%	100.00%	2.44%	0	0.00%	0.00%	0.00%
	Sophisticated machine learning algorithms											
	At the beginning of the implementation				Partially implemented				Advanced implementation			
	N	Column	Row	Total	N	Column	Row	Total	N	Column	Row	Total
Up to 10%	26	78.79%	96.30%	63.41%	1	20.00%	3.70%	2.44%	0	0.00%	0.00%	0.00%
11-30%	7	21.21%	53.85%	17.07%	3	60.00%	23.08%	7.32%	3	100.00%	23.08%	7.32%
Over 30%	0	0.00%	0.00%	0.00%	1	20.00%	100.00%	2.44%	0	0.00%	0.00%	0.00%

Table 10. Hypothesis testing: percentage of investments from the total hotel revenue in the last three years/digital technology (Authors)

The percentage of hotel investment from total revenue in digital technologies By Cloud technology						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0
Pearson	2.716	0.6065	4	9.488	0.05	is accepted
The percentage of hotel investment from total revenue in digital technologies By Automation, process optimization, interoperability of functions						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0
Pearson	8.154	0.0861	4	9.488	0.05	is accepted
The percentage of hotel investment from total revenue in digital technologies By Energy management						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	H_0
Pearson	7.497	0.1118	4	9.488	0.05	is accepted
The percentage of hotel investment from total revenue in digital technologies By Sophisticated machine learning algorithms						
Test	ChiSquare	Prob>ChiSq	df	ChiSquare (t)	Prob>ChiSq (t)	**H_0 not accepted Ha is accepted**
Pearson	18.432	0.001	4	9.488	0.05	
Pearson	19.309	0.0007	4	9.488	0.05	

3.3. Key results and discussion

In presenting the results of empirical research on the use of digital technologies in the hotel business in Serbia in 2021, concerning the achieved level of digitalization based on selected hotel characteristics, various statistical significances can be observed.

The level of implementation of researched digital technologies in the hotel category can be assessed as the medium in the implementation of cloud technology, energy management, and automation and low in machine learning technology. The Chi test methodology did not identify a statistically significant difference between four- and five-star hotels in the implementation of these technologies. The zero hypothesis of H0, that there is no statistically significant difference between the highest categories of hotels, is confirmed.

The level of implementation of researched digital technologies for hotel revenue level in 2021 hotels (those up to 70 thousand euros, those from 70-150 thousand, and those from 150 thousand to 2 million euros), through the Hi test, indicates that there is no statistically significant difference relating to technology implementation: cloud, digital technology, automation, and energy management. When applying the technology of sophisticated machine learning, there are statistically significant differences between the hotels according to the revenue level, and with this technology, an alternative hypothesis Ha can be accepted.

The level of implementation of researched digital technologies concerning the amount of investment in these technologies from hotel revenues in the last three years of business implies some differences. H0 on the absence of statistically significant differences can be accepted for the following technologies: cloud, automation, and energy management. Since there is a significant difference in investments in modern technologies depending on the level of hotel revenue for machine learning, then an alternative hypothesis is accepted in that case.

It can be noticed in the paper that automation technologies and conversions of analog to digital information in business were applied in the initial phase of digitalization in the vast majority of hotels, to save costs and more efficient development of resources for existing activities. Reaching the next level is a much more challenging goal. Adding digital technology components to hotel services, and introducing digital distribution and communication channels in the mid-level digitalization of hotel business, with agile digital network resources, points to a digital growth strategy and goals reflected in cost reduction and revenue growth, more efficient service policy and shifting focus to customer experience enhancement. Advanced technologies such as robots and artificial intelligence have not been considered. The application of advanced technologies requires hotels to radically transform the business

architecture through which they create and capture value which includes reformulating the strategy, business model innovation, and radical change.

Over the past few decades, researchers have tried to determine the effects of IT on hotel performance using numerical measurements. Previous studies have found a positive link between ICT and operational productivity (Sirirak et al., 2010), as well as between ICT and competitiveness (Hua, 2020). Reviewing the relevant literature about this subject in the previous decade, Khatri (2019) concludes that IT is increasingly used to create value and gain a competitive advantage, as well as to improve internal business processes. Han et al. (2021) emphasize that customer experience enhancement is the leading goal in the adoption and implementation of digital technologies. The literature points out that in the hotel business return on investment in contemporary technologies is a topic that has not yet been clarified and requires further improvement and metrics (Morosan & DeFranco, 2019). Hua (2020) points out that the effects of investing in modern technologies are manifesting in the long run. In that sense, this research theoretically contributed to further correlation between investments in various digital technologies in terms of hotel characteristics, which they realized by understanding the importance of these technologies in maximizing their goals, developing strategy, and building a business model. In this sense, this work theoretically contributes to further correlation between investments in various digital technologies in terms of hotel characteristics, which are realized by understanding the importance of these technologies in maximizing their goals, developing strategy, and building a new business model.

4. Conclusion

Of the four researched digital technologies, the one used the least by the four- and five-star hotels in Serbia is sophisticated machine learning. Compared to the selected hotel

categories, the difference in statistical significance was shown in the revenue level and income from investments from realized revenues in the last three years in sophisticated machine learning technologies. Most of the respondents classified the achieved level of digitalization of hotels in the middle category. It should be noted that the selected sample is over 30% of the total number of hotels of higher categories (4 and 5 stars) and these hotels are expected to enter the modernization and technological development and achieve higher implementation of digital technologies.

The results of this research on the differences in the level of investment, depending on the total hotel revenue, in technology and the achievement of different levels of implementation in the digitalization of business, contribute to the choice of strategic imperatives of hotel companies. In line with the strategic goals of digital transformation, the introduction of contemporary technologies should be viewed as a group of technological and organizational changes needed to realize a certain phase of the achieved level of digital technology implementation (initial, intermediate, or advanced level).

The paper contributes to theoretical considerations on the levels of implementation of certain digital technologies, innovations by stages of hotel digitalization, and strategic goals of hotel development and the means needed for that through investments in digital resources, growth strategy, and new business models. It practically contributes to the work of hotel management, employees, and interest groups, awareness of the benefits arising from the application of these technologies and their digital literacy, and private sector development.

The limitations of the work are reflected in the choice of four digital technologies, and three characteristics of the hotel. The paper does not consider more advanced digital technologies such as artificial intelligence and robots, where the likely result would be similar or weaker compared to machine learning algorithms. This research stimulates interest in the further adoption of advanced technologies in the hospitality sector in Serbia. For a wider benchmarking in the region, it would be useful to explore the achieved levels of implementation of digital technologies in four- and five-star hotels in the countries of the region.

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