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The effects of the aesthetics and composition of hotels' digital photo images on online booking decisions

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Photographic images help customers perceive product information more accurately and clearly. A customer's perception of a particular product also influences their decision to purchase it. In the context of a hotel, guests evaluate digital hotel photos online during their booking decision process. While a large body of research has contributed to the understanding of how hotel online digital images shape hotel customer behaviour, little is known about the aesthetics, content, and composition of hotel images and their effects on booking decisions. In addition, previous research has routinely been criticised for having methodological limitations. These studies have routinely used surveys and experiments to explore how hotel pictures affect customer perception of the hotel and his/her booking intentions. Unlike prior studies, this research scopes a determination of the 'selling' properties pertinent to the hotel's digital images placed online on the hotel-themed websites with the application of the latest technologies pursuant to visual data mining, processing and analysis. This study employed Google's Inception v3 neural network as an AI solution for embedding and classifying hotel photo images with the further application of logistic regression and fuzzy cognitive mapping method. The results of the present study determined the hotel picture properties that may engender positive customer perception of the hotel and sequentially can precipitate hotel booking. The revealed 'selling' hotel image properties comprise (a) light and time of the photo shooting, (b) image colour scheme, (c) human presence, and (d) shooting angle. This study suggests a set of practical recommendations to hotel marketers to develop 'selling' photo images that generate hotel bookings online. The completed research is one of the first in the nascent literature stream in AI-powered computer vision solutions studies to determine the effects of photo aesthetics on online hotel bookings.

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Introduction

Photography and digital images accompany many facets of human life (Langford, 2013). Visualising the surrounding world through photographic images engenders humans' comprehension of the environment where they exist (Balomenou and Garrod, 2019). According to neuromarketing research, the human brain processes visual information 60,000 times faster than information received by reading a text (Weber, 2019). Moreover, researchers in marketing have determined that individuals known as visual learners represent most of the world's population (Kędra, 2018). Such a significant peculiarity pertinent to human behaviour as perception through visualisation has proliferated a research stream in the domain of marketing which examines the effects of visual appearance presentation on the product's commercial performance (Kirillova and Chan, 2018).

Marketing literature has posited that photographic images help customers to perceive product information more clearly and precisely (Creusen and Schoormans, 2005; Van der Burg, 2021). Product images help customers build stronger associations with the product than text (Li et al., 2022). Furthermore, such a perception predisposes a customer's decision to purchase a particular product (Evanschitzky et al., 2012; Homburg et al., 2015).

Nonetheless, researchers in marketing stress the pivotal role of professionally shot and developed photographs because image quality creates more customer engagement and stimuli for product consideration and purchase (Li and Xie, 2020). Conjointly with other variables, online photographic pictures improve the quality of online communications with customers and leverage their loyalty to the brand (Rodríguez et al., 2020). Moreover, in this regard, under the effect of high-quality product photo images, customers' buying decisions may often lack self-control and be impulsive (Yang et al., 2022). Finally, several notable studies have demonstrated that both the variety and the typology of sources of information and communication to which individuals are exposed during their customer journey have a significant effect on the formation of the perceived image breadth of the destination (Andrade, 2012). The latter denotes posting photos to social media that share information about the destination or hospitality organisation, advise tourists about the customs pertinent to the host communities and attract future visitors (García-Henche, 2018). Thus, photography is a powerfully customer-engaging means of communication throughout the stages of trip planning, executing a trip, and sharing post-journey customer experiences.

In hotel settings, customers evaluate digital hotel photos online in their booking decision process (Espigares-Jurado et al., 2020). Complemented by textual information comprising hotel facilities and services description, lodging availability and accommodation rates, digital hotel visuals expedite the customers' hotel booking planning process (Kim et al., 2021). Hence, deliberation and scope on the hotel digital web photos are significant for hotels because the online visuals represent a practical instrument to persuade customers of their hotel choice. Also, online hotel images may flag the onset phase of a customer's emotional experience with the hotel and destination (Quynh et al., 2021). Furthermore, the crucial point in the hotel online image examination is to discern what makes them visually arresting and influential, e.g., what photography content and composition is capable of driving consumer behaviour amid the booking decision sequence.

An extant body of hotel marketing literature has noted the importance of hotel online images and addressed the research question about their effects on customer booking behaviour. In this domain of studies, researchers determined the positive effects evoked by the larger number of digital hotel images and their shorter text descriptions (Bufquin et al., 2020). Furthermore, prior research has determined that appropriate reflection of the hotel's appearance, aesthetics and design symbolism communication in the hotel's online images may generate greater customer expectations and thus predispose booking decisions (Baek and Ok, 2017; Kirillova and Chan, 2018). Another notable study in the relevant research domain investigated the role of hotel picture positioning on the website. It verified that different image locations on the webpage generate varied effects on customer booking intentions (Espigares-Jurado et al., 2020).

Although the above-noted studies have advanced the understanding of the effects of hotel online digital pictures on customer behaviour and contributed to hotel marketing theory, little is known about the hotel images' aesthetics, content and composition influence on booking decisions. Moreover, prior researchers consented to the methodology limitations as extant studies have relied on surveys or experiments for data collection and quantitative methods to measure customers' perception of the hotel pictures plus their effects on booking decisions (Bufquin et al., 2020). Simultaneously, innovative visual data processing and analysis techniques such as computer vision artificial intelligence emerged but have not been amply applied in hotel marketing research until most recently. Researchers contend that AI-themed studies proliferation is nascent because of the ubiquitous artificial intelligence capabilities intrinsic to product personalisation, standardisation, and customer relationships (Flavián and Casaló, 2021).
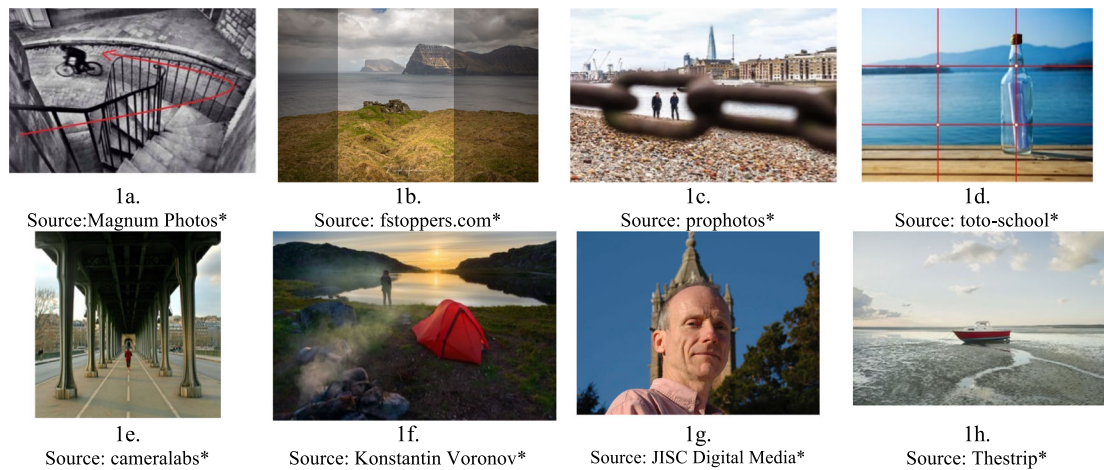
Consequently, this research aims to determine the effects of the hotel's digital online image composition, content, aesthetics, essential photography elements, and principles on customer booking decisions. In addition, this study aims the developing a model capable of predicting hotel booking grounded in data science and computer vision solutions application. In accordance with the stated purpose of the research, this study poses the following research question:

> RQ: What aesthetics, composition and image elements relevant to hotel photography determine the positive effects on hotel online bookings?

This study discusses the alternative perspective of customers' online booking behaviour comprehension. Also, this exploratory research contributes to the theory of tourism and hotel marketing by systemising the seemingly haphazard hotel digital picture aesthetic elements with the help of the latest data analysis technologies and suggesting a theoretical model relevant to customer booking decisions driven by the digital hotel images placed online. From the grounds of managerial implications arising from the present study, the present paper equips hotel marketers with rules and elements for shooting and processing visually arresting photographic images that improve hotel selling capabilities.

Literature review

Photography computational aesthetics, photography elements and principles. Although every individual has a different preference and perception, all humans are willing to find beauty in the arts to please themselves (Yeh et al., 2014). Prior studies noted a complexity in achieving a goal of a uniform approach to photo art creation (Jin et al., 2012). Consequently, extant literature has posed a scarce consensus on why one photo image is more aesthetically pleasing than another (Liu et al., 2010). In this vein, researchers have pointed to the human experience, emotions, and personal orientation that determine aesthetic judgement (Zhang and Xu, 2020). Photography research coined a notion of computational aesthetics that denotes a proliferating stream of studies to tackle these concerns (Liu et al., 2010). Computational aesthetics is an

1a.
Source:Magnum Photos*

1b.
Source: fstoppers.com*

1c.
Source: prophotos*

1d.
Source: toto-school*

1e.
Source: cameralabs*

1f.
Source: Konstantin Voronov*

1g.
Source: JISC Digital Media*

1h.
Source: Thestrip*

Fig. 1 Basic rules of photo aesthetics and composition. Directional lines (**a**); image orientation and colours (**b**); framing (**c**); rule of thirds (**d**); image symmetry (**e**); image depth and angle (**f**); objects planning/details (**g**); light/time of day (**h**).

area of research implying a nexus of science and arts. It aims to predict the human reaction and emotional response to artworks (Wei-Ning et al., 2014; Bo et al., 2018). Among many of its assignments, computational aesthetics challenges the significant objective of creating precise rules for photography composition and elements (McCormack and Lomas, 2021).

Composition is a significant property relevant to photography (Kress and Van Leeuwen, 2020; Chong et al., 2022). The essence of the composition is the arrangement of elements in the frame to attract the attention of the audience. Literature contemplates composition as the photo's foundation (Obrador et al., 2010; Langford, 2013). To a greater extent, photo composition is the subject of the photographer's decision (Freeman, 2007; Liu et al., 2010). However, there are specific basic composition techniques that photographers must follow to create photographs of popular genres, architecture or portraits (Präkel, 2006; Liu et al., 2010; Mavridaki and Mezaris, 2015) (Fig. 1).

According to the accumulated research, computational aesthetics and composition rules are also highly relevant to hotel photography (Baek and Ok, 2017; Amin et al., 2021).

Hotel digital images in hotel e-commerce. Literature highlights the significance of photography in hotel marketing (Kirillova and Chan, 2018; Back et al., 2020; Kim et al., 2021). As priorly noted, the issue of product intangibility is substantial in the hotel due to customers' inability to perceive the location, room interior, amenities, smell, and room view before checking in the hotel. The noted issue urges customers to evaluate the hotel through online digital photo images (Baek and Ok, 2017). In this line, one experimental study documented a 225% boost in hotel booking with solely one hotel photograph placed online (Reichek, 2016). Besides, photography improves hotel webpage appeal for customers because online hotel images reduce cognitive load and simplify booking decisions (Pan and Zhang, 2016). Furthermore, more recent studies confirmed that online images engender customers' confidence in hotel services (Espigares-Jurado et al., 2020).

Nonetheless, researchers have discovered an effect of ambiguity relevant to photography utilisation in hotel online marketing (Chan et al., 2020). That is, the "the more is better" approach in the hotel digital image placement may generate adverse effects on customer booking intentions. Such effects have a linkage to the

phenomena known in marketing as "choice paralysis" which occurs when a firm offers too many product options to its customers (Gourville and Soman, 2005). In hotel settings, hotels should employ images solely relevant to the hotel property. These photos must not mislead customers (Kuo et al., 2015).

Additionally, hotel online digital images have to communicate the physical evidence of the service value to the potential customers (Liu et al., 2022). To communicate the value of their services, hotels tend to utilise six types of photography settings in their online marketing, comprising (a) hotel room; (b) hotel room bathroom; (c) hotel entrance and lobby; (d) hotel exteriors; (e) hotel premises and services; (f) conference rooms (Ren et al., 2021). Simultaneously, resort hotels include images of the landscape and beach in their visual communications.

Hotel photography aesthetic properties effects on booking decisions. Researchers have previously addressed research questions pertinent to examining the hotel digital image properties that generate effects on hotel booking. In this line of research, Back et al. (2020) investigated the influence of digital photo size and human images on booking decisions. By employing a transportation theory (Green and Brock, 2000), Back et al. (2020) determined that larger digital photo images increase customers' booking intentions and willingness to pay more for accommodation. Another significant finding documented in that study is that larger photos are more effective if humans are not present there. On the contrary, human presence increases the performance of the smaller images. Transportation theory elucidates such controversial findings as humans tend to imagine themselves present in the depicted environment. Larger photo images serve better for such aspirations, amid other human images in the same photographs may hamper these imaginations (Back et al., 2020).

In another notable study, Bufquin et al. (2020) determined that customer booking intention is linked to the hotel site or webpage browsing enjoyment. According to that research, the number of high-quality photo images and their shorter text descriptions precipitates browsing enjoyment. However, in line with the priorly noted "choice paralysis" issue, the authors stress that an excessive number of hotel images diminishes hotel webpage browsing and thus deteriorates customer booking decisions (Bufquin et al., 2020).

Reichek (2016) complemented a stream of hotel photography research by utilising a facial electromyography method (Li et al., 2018) to examine the hotel images that coax customers to make a hotel booking. The experiment participants reacted positively to the hotel room images, which had an abundance of natural light entering the room. The study determined that the photos showing various room spots taken from different angles created a feeling among site visitors that they were getting a complete and accurate perception of the place. The same study also verified the photography aesthetics and composition requirements relevant to the hotel's digital images. Besides, photos of the public hotel spaces and exteriors, including hotel entrances, gardens, patios, beaches and sea views, appealed to the study participants. Finally, that study suggested several recommendations for photography aesthetics and composition rules appropriate to hotels (Reichek, 2016).

Collectively, the reviewed studies outline a pivotal role of photography aesthetics, composition and elements because they affect customer online experience, create customer enjoyment and thus increase the probability of hotel booking. Nonetheless, extant research has applied surveys and experimental study approaches to predict online customer behaviour while simultaneously lacking a more precise and cogent methodology to determine hotel booking intentions.

Methodology

Data collection. This study used a random multi-stage sampling method for data collection using a random digit generator. First, to select a setting for this research, we employed an online generator to return a telephone area code from the uploaded list comprising top tourist destinations worldwide. The random digit generator returned an area code of +3493, which belongs to Barcelona, Spain. Second, we programmed a random digit generator to return the hotel 'star' rating between 2 and 5 to mitigate the possible bias in the research results caused by the multiple hotel classes selection. Third, the generator received a command to define the number of photographs per hotel to receive visual data that represents the sampled hotel property. The generator picked '6' as a hotel image quantity for each hotel in the sample. Fourth, we opted for Booking.com as a data source because it contains all the essential information required for this study in one place. The hotel search for the 4-'star' hotels available for booking in Barcelona returned 225 hotels. As a result, 1350 hotel digital online photos were collected for further data analysis.

Furthermore, it is possible to obtain values from booking.com for the binary target variable used in this research which is a mode value of the booking event ("Yes"—1, "No"—0) of the specific hotel in the last hour. A mode value of the booking event results from observing and recording every 6th hour (four times) during one day if the hotel was booked in the last 60 min before observation. Finally, based on recommendations from Ren et al. (2021), we analysed the frequencies of the website hotel photo settings to consider them in image distribution for every 6 photos selected for each hotel. This preliminary analysis makes it possible to select 2 photos of the hotel room, 1 hotel room bathroom, 2 exterior hotel photos and 1 photo depicting the hotel lobby. As explicated further in this section, the present research utilises image embedding with Google Inception V3, explicated further in this section. This neural network is pre-trained on a large set of photo images and can classify photos even in small test samples (Qiang et al., 2019; Vishwakarma and Thakur, 2019).

Data analysis procedures. According to the most recent hospitality literature, AI computer vision and deep learning are novel and robust frameworks that can help researchers to attain more

precise results in exploring online visual content (Ren et al., 2021). Unlike recent studies employing surveys or experiments solely to determine photo properties' effects on hotel booking, this research employs a computer vision solution based on artificial intelligence to recognise selected hotel images and classify them according to the booking event occurrence. The mechanism of image embedding and processing is executed by image-processing neural networks that split digital images into pixel tags, also referred to as visual descriptors. Visual descriptors contain data on the image properties comprising colour, shape, texture, and other features. There are two known classes of visual descriptors, including (a) general image information (colour, shape, texture) and (b) specific image domain information (objects and events). For instance, the latter class is used for face recognition (Godec et al., 2019).

For image embedding and classification, we utilised Google's Inception v3 model. This model denotes a convolutional 48–layer neural network trained on 1.2 million images from the ImageNet data depot. Google's Inception v3 model is credited for its capability of precise image recognition because it demonstrates an algorithm accuracy greater than 78% (Szegedy et al., 2016). In the next phase of the data analysis, we applied a cross-validation method to verify how well the image can predict possible hotel booking. Established machine-learning methods like logistic regression, support vector machines (SVM), and neural network with a multi-layer perceptron (MLP) algorithm with back-propagation are appropriate for this task as the present research has a binary target variable (Coenen et al., 2022).

In the final data analysis phase, this study implemented an approach known as fuzzy cognitive mapping (Nair et al., 2019). The 'fuzziness' in cognitive mapping makes it possible to manifest vague causality levels between objects (Gao et al., 2020). A fuzzy cognitive map visually represents the linkages between analysed objects. When applying this method, researchers rely on their assumptions, perception and knowledge to elucidate their concepts and links between those concepts by drawing a visual scheme. In this research, we implemented fuzzy cognitive mapping to investigate and delineate the 'selling' hotel digital photo aesthetics and composition predisposing hotel booking. For such a purpose, grounded in the reviewed literature, we employ the image properties comprising objects depicted on the photos, shooting angles, photo shooting's time of the day, human presence, and colour scheme as fuzzy cognitive map concepts.

Results

Image embedding and logistic regression. This research aims to discern the hotel's digital photography aesthetics, composition, and elements that affect customer booking decisions online. In accordance with the aim of the study and developed methodology, we ran penultimate layer activations for image embedding using Google's Inception v3 model, which rendered $n = 2047$ image descriptors as the image embedding procedure's output. This artificial intelligence procedure performed the iterative analysis of the images and returned a table with descriptor ratio values (n_n) for each of the 1350 hotel photos in the data set. Three hotel photos were neglected by Google Inception and thus discarded from the embedded images dataset. Table 1 depicts the fragment of the generated dataset (Table 1).

Next, we assigned the received image descriptors as feature variables. We supplemented the generated dataset (Table 1) with a column containing a dichotomous target variable to apply analytical procedures to the updated data. We implemented three priorly noted machine learning procedures to build a predictive model, including logistic regression (balanced distribution, strength

Table 1 The excerpt from the dataset generated by Google's Inception v3 image embedding.											
Image name	n_0	n_1	n_2	n_3	n_4	n_5	n_6	n_7	n_8	n_9	...n_{2047}
Hotel_1_Ext2	0.71	0.26	0.31	0.11	0.36	0.22	0.24	0.15	0.12	0.27	0.61
Hotel_1_Ext1	0.70	0.61	1.05	0.63	0.79	0.23	0.15	0.77	0.39	0.72	0.18
Hotel_1_Roo1	0.11	0.23	0.10	0.07	0.02	0.11	0.27	0.31	0.19	0.03	0.48
Hotel_1_Lob1	1.43	0.13	0.47	0.72	0.07	0.62	0.64	0.45	0.16	0.11	0.58
Hotel_1_Roo3	0.04	0.19	0.47	0.13	0.10	0.32	0.09	0.41	0.22	0.04	0.25
Hotel_1_Roo2	0.06	0.30	0.02	0.13	0.04	0.10	0.17	0.34	0.38	0.17	0.21
Hotel_2_Roo2	0.18	0.50	0.18	0.02	0.27	0.73	0.08	0.75	0.31	0.32	0.12
Hotel_2_Roo3	0.10	0.20	0.02	0.18	0.22	0.15	0.08	0.40	0.25	0.03	0.40
Hotel_2_Roo1	0.10	0.39	0.13	0.63	0.19	0.36	0.41	0.49	0.43	0.15	0.09
Hotel_2_Ext1	0.15	0.18	0.19	0.33	0.28	0.34	0.20	0.58	0.90	0.29	0.79
Hotel_2_Lob1	1.05	0.11	0.43	0.33	0.07	0.98	0.17	0.08	0.40	0.25	0.05
...Hotel_255_Img$_n$	1.36	0.14	0.79	0.02	0.30	0.71	0.15	0.38	0.32	0.66	0.63

Table 2 Model fit statistics.					
Model	AUC	CA	F1	Precision	Recall
Logistic regression	0.614	0.578	0.577	0.578	0.578
SVM	0.881	0.806	0.806	0.806	0.806
MLP Neural Network	0.903	0.830	0.830	0.830	0.830

"Recall" is value implicit to the true positive values proportion in the set of really positive observations (Error type I); "AUC" is a square area below a ROC curve line of model prediction power (Fig. 2); "CA" is a classification accuracy and denotes the share of instances correctly classified; "F1" is a mean of precision and recall harmonically weighted, $F1_{score} = 2 \cdot \frac{(Precision \cdot Recall)}{(Precision + Recall)}$.

$C = 1$, ridge (L2) regularisation type), SVM (regression loss epsilon $\varepsilon = 0.10$, cost $C = 1.00$, RBF kernel, numerical tolerance $= 0.0010$, iteration limit $= 100$), and MLP neural network (neurons in hidden layers $n = 400$, activation $=$ rectified linear unit function (ReLu), solver for weight optimisation $=$ Adam (stochastic gradient-based optimiser), regularisation $\alpha = 0.0001$, the maximum number of iterations $= 200$). Table 2 depicts the model's outputs after the sequential application of the procedures. These results unveil that MLP neural network exhibits better score values of the model fit statistics in comparison with SVM and logistic regression (Table 2, Fig. 2).

The resulting MLP neural network model accuracy measure is >70%, so it reveals an acceptable degree of prediction power (Aziz et al., 2017). However, even with such a degree of precision, it is useful to analyse image misclassifications in the developed model. The confusion matrix returns the shares of correctly or incorrectly predicted instances and actual cases (Fig. 3). With the utilisation of the confusion matrix, it is possible to extract and analyse the specific instances that are misclassified.

Fuzzy cognitive mapping. At the preliminary data analysis stage, the prediction model run by a logistic regression algorithm assigned each photo a value, which indicates the probability of the booking event for the particular hotel digital image. Further on, in accordance with the recommendation by Campbell (2021), we selected the images that exhibited strong prediction values of ≥0.6 for the following analysis stage, employing fuzzy cognitive mapping. The application of this requirement fetched a set of 258 'selling' hotel photo images. The following table exhibits various sample photos that received the highest probability degrees of hotel booking according to the outcomes of the logistic regression application (Fig. 4).
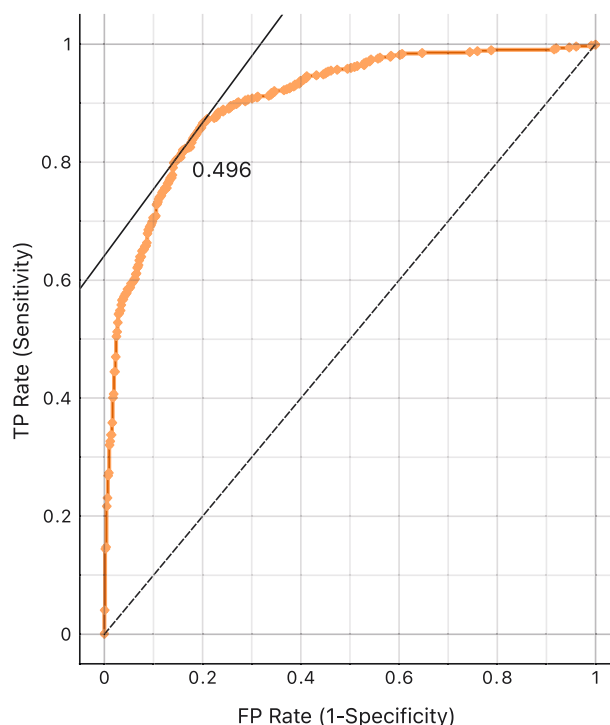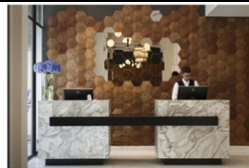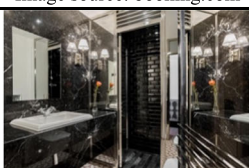
Fig. 2 Multilayer perceptron neural (MLP) network ROC curve. ROC curve stands for receiver operating characteristic curve. It depicts a compromise between classifier model sensitivity (TP (true positive) rate on the graph) and classifier model specificity (FP (false positive) rate on the diagram). Classifiers returning the ROC curves closer to the top-left corner (TP rate is near its maximum of 1) exhibit better model performance.

Fig. 3 Confusion matrix for MLP neural network. The confusion matrix measures classifier performance for models with dependent variables with two (0 and 1 in this figure) or more output values (classes). It depicts the percentage of correctly or incorrectly predicted classes in the model.

Then, we examined the hotel photo images with high (≥0.6) probabilities of booking and classified them according to the fuzzy cognitive map concepts delineated in the methodology section (Table 3).

Photo categories/prediction	Sample photo 1*	Sample photo 2*	Sample photo 3*
Exterior			
Booking prediction	**0.999749** Image source: booking.com	**0.995312** Image source: booking.com	**0.986148** Image source: booking.com
Hotel lobby			
Booking prediction	**0.997729** Image source: booking.com	**0.989892** Image source: booking.com	**0.913344** Image source: booking.com
Hotel room (bathroom)			
Booking prediction	**0.99915** Image source: booking.com	**0.942994** Image source: booking.com	**0.930605** Image source: booking.com
Hotel room (bedroom)			
Booking prediction	**0.999243** Image source: booking.com	**0.99806** Image source: booking.com	**0.981908** Image source: booking.com
Hotel room (balcony view/ window view and living room area for suites)			
Booking prediction	**0.991665** Image source: booking.com	**0.989955** Image source: booking.com	**0.969438** Image source: booking.com

Fig. 4 The top-selling hotel photograph samples determined by logistic regression. The chart exhibits three sample photos for each of the five composition categories (hotel exterior, lobby, and three room views) routinely utilised in hotel photography. The numbers under images indicate the prediction values of the hotel booking probability impelled by each photo according to the outputs of the logistic regression application.

To concretise the data in Table 3, we built a fuzzy cognitive map that depicts and explicates the rules for effective photography in hotel settings (Fig. 5).

Note: How to read this map—for example, to achieve a better degree of shooting hotel exteriors photo, a photographer has to make sure that people are not present in the frame (yellow connection line) and prefer a subtle colour scheme (light emerald connection line) and take a photo from a straight angle (light blue connection line). The time of the day and lighting is not critical, but the shooting session will benefit from a sequence of day and night-time photographing (purple connection line). Swimming pools or beachside are significant objects in the exterior photos.

Rectangles in Fig. 5 are pursuant to the examined photo classes (exterior, lobby, and three subclasses of room photos), ovals

represent the hotel photo's aesthetics and composition (human presence, colour scheme, angle, time of shooting), and coloured hexagons are implicit to aesthetics and composition properties adapted from the recent research. The obtained research results denote several intriguing findings that we will discuss further in the next section.

Discussion

Implications for theory. The accomplished research further advances the marketing theory in hotel settings in several ways. First, this research is one of the first in the stream of hotel marketing literature that applies artificial intelligence neural networks to determine a powerful digital photo computational aesthetic elements constellation that invokes hotel bookings.

Photo classes	n photos	Time of day	Angle	Human presence	Colour scheme
Table 3 Taxonomy of the 'selling' hotel photo image properties determined by AI.					
Exterior	23	Any time of day The pool photos are shot in sunny weather with a blue sky. Natural light	From above for swimming pools; straight angle for hotel entrances.	No human presence	Monochromic. Shades of light brown or dark grey. The exterior of the hotel harmoniously fits into the surroundings.
Hotel lobby	12	Any time of day. Natural light and artificial light	Angled from the opposite side of the lobby.	Reception staff is always present.	Monochromic brown or black and white. All photos have red elements.
Hotel room (bathroom)	10	Artificial light	Angled from the corner of the room or a doorway of a rectangular shape room.	No human presence.	Subtle colour scheme. Most photos use three colours of white, brown and grey.
Hotel room (bedroom)	7	In the daytime with natural light from the window	Angled from From the corner of the room or from a doorway if the room has a rectangular shape.	No human presence.	Subtle colour scheme. Most photos use three colours of white, brown and grey.
Hotel room (balcony view/ window view and living room area for suites)	4	Any time of day	Angled mainly from the room window	No human presence.	Most photos have white, brown and grey. Strong accent on pillows or vases with flowers in.
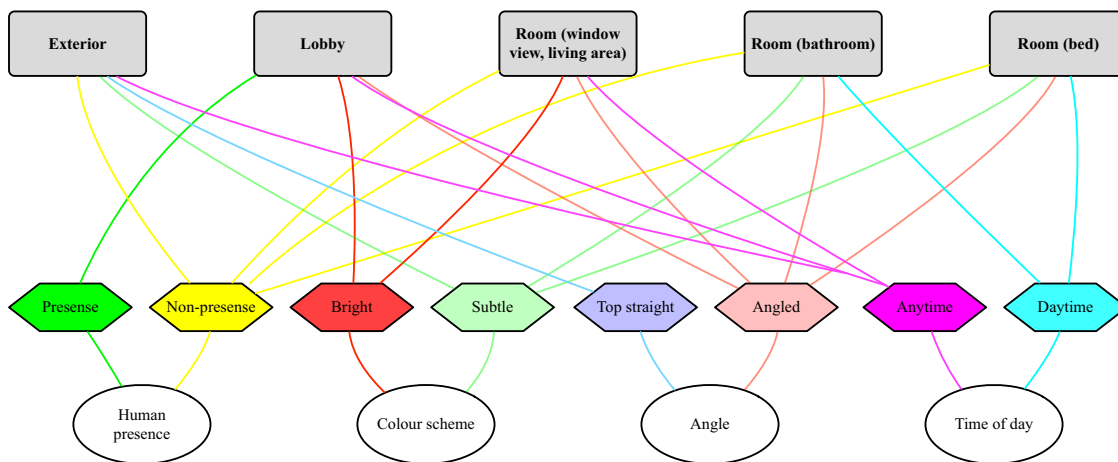
Fig. 5 Fuzzy cognitive map of the 'selling' hotel photography image properties. Grey rectangles indicate hotel photo composition categories, coloured hexagons represent hotel photography technique variations to be applied with composition rules, and white ovals point to the composition rules in hotel photography. Linking lines are coloured to simplify understanding of how the composition rules and their varied techniques can be applied in shooting each hotel photo composition category.

Conversely, prior studies have relied on surveying and lab experiments methodologies to determine hotel photo image effects on customer behaviour, thus measuring customers' perception of the hotel photos and booking intentions, not the actual bookings.

Second, until most recently, marketing academia has subjected photo aesthetics solely to neuroscience (Casado-Aranda and Sanchez-Fernandez, 2022). On top of that, prior research noted that the emerging stream of AI-themed literature is still quite conceptual (Flavián and Casaló, 2021). By applying an advanced technologically savvy methodological approach, the present study confirmed the plausibility of the hotel online images' significance in customers' online behaviour and booking decisions. This finding is in line with the accumulated research (Baek and Ok, 2017; Kirillova and Chan, 2018; Bufquin et al., 2020).

Third, a stream of amassed research relevant to customers' online hotel choices asserts that online customer behaviour and booking decision process in the OTA websites have a complex and sophisticated nature (Manes and Tchetchik, 2018; Amin et al., 2021). A mix of critical factors, including hotel room rate,

guest hotel rating and review sentiment, location, hotel specialisation, facilities, and brand, affect a customer's decision to book a hotel (Lien et al., 2015; Liu et al., 2017). Nonetheless, an extant body of research lacks consensus, whereas different authors suggest eclectic sets of hotel choice factors. Moreover, academia argues that the valence and the effects of the single hotel choice factors are multifaceted and thus idiosyncratic. In this line, prior research has noted that low prices and discounts do not necessarily act as a stimulus for hotel booking (Hu and Yang, 2020). Simultaneously, even a perfect location cannot guarantee that the hotel will be fully booked (Aksoy and Ozbuk, 2017). Positive online reviews generate effects on hotel consideration but do not completely ensure online booking (Gavilan et al., 2018).

Interestingly, prior studies in the vein of the hotel choice factors commonly neglected the inclusion of online photo images into the mix of these factors. The outcome of the present study argues that the developed model can precipitate online hotel booking through the photos' composition, elements and aesthetics. Nonetheless, we assume that customers take additional underlying hotel choice factors into consideration while making

their final decision to book a hotel. That said, appropriately created online hotel images add more argumentation to the booking decision by rectifying/mitigating the hotel advantages or disadvantages uncovered by the customer in the hotel pricing, location, reviews and so on.

Fourth, based on the combination of Google's Inception v3 computer vision solution and logistic regression, this study develops a working model capable of evaluating digital images in hotel photography. Prior AI research in the field of computer sciences has solely built hotel image classifications and framed the complexity of determining the causal linkages between hotel image composition and customer behaviour. These studies have not revealed such causality and proposed to employ the supplementary AI-surveys-experiments methods to determine its existence (Overgoor et al., 2020). Meanwhile, the developed AI-empowered model can estimate the power of the hotel's digital online image composition, its elements and aesthetics to nurture hotel booking decisions. Moreover, this research outcome further develops extant literature in marketing and computer sciences domains as it validates the suitability of computer vision solutions to address various research questions in both fields.

Finally, grounded in computer vision and fuzzy cognitive mapping, this study reveals several properties of the 'selling' hotel images indicating a noteworthiness for the hotel marketing literature. In this vein, human presence in the photo minimises positive effects for exterior and room facilities images but is essential for the photos depicting the hotel lobby. This finding is in line with the outcome of the prior studies regarding the hotel exterior and room images (Back et al., 2020). Furthermore, by examining the use of natural light and shooting photos from different angles, the findings of this research support prior studies that have attained similar outcomes (Reichek, 2016).

Managerial implications. The significance of communication and image promotion of the hotel services generates the influence on potential tourists when they make their decisions and, sequentially, gives rise to the customer satisfaction derived from the tourist experience (Andrade, 2012; García-Henche, 2018). In this line, it is essential to study the differences in a given destination's image perception by visitors and non-visitors. Such an objective allows for determining particular photo image attributes influencing existing and potential customers. Furthermore, obtaining information on the efficient photo image attributes is essential for the strategic planning process in hotel services. In addition, it is significant to investigate the relationship between the perceived and the projected image of the tourist destination generated by the hotel photographs. Ignorance of the photographic images' potential as a mediating resource between a visitor and the hotels has impeded the development of a broader and clear initial hotel perception. Such ignorance may complicate attracting hotel guests. Conversely, appropriate hotel photography employment generates a greater tourist intention to book a hotel (García-Henche, 2018). However, it is imperative for hotel managers to realise the complex nature of the customer's decision-making process, where hotel photos can serve as a supplementary hotel selling argument to the other choice factors pertinent to room rate, location, guest reviews and rating (Liu et al., 2017).

From the standpoint of hotel marketing practices, this research has managerial implications significant for hotel marketing specialists. We suggest hotel marketers consider the results of this study in developing their briefings to photographers when they plan a photo shooting session. In general, we recommend that hotel marketers and hired photographers highlight the hotel's unique properties in the images, employ landscape orientation for web pages, use the visual valence of the natural light, and consider

symmetry and the rule of thirds in the hotel photo composition. Furthermore, we recommend hotel marketers follow the instructions for photo shooting in various locations. Before delineating the suggestions for efficient hotel photo shooting, it is worth noting that photos on social media substantially exert influence on users and engender their sensations. Hotel marketers may render ideas from these influential social media images.

For instance, when planning a photo shoot for the hotel room premises, hotel marketers need to ensure that the photo set of this category should comprise at least four images, including the compulsory photo image of the bathroom. The room picture would benefit from the angled shooting as this composition creates the customer's perception that the room has ample spaciousness. Concerning the bathroom, for the sake of high-quality photography, towels and bathrobes must be white and folded neatly. Hotel photographers must avoid taking photos of humans in the room since human presence impedes customers' imagination of being in that hotel room, according to the transportation theory (Green and Brock, 2000; Back et al., 2020). We suggest hotel marketers capitalise on the room window's stunning views if available. According to Reichek (2016), 70% of study participants indicated this hotel images category as significant in their online hotel shopping and booking.

In concluding the guidance on hotel room photography, our recommendation for shooting a hotel suite is to make the hotel living room more 'lively' and 'liveable' by adding warming details, for instance, flowers in the vase or a bottle of wine with two glasses served on the white napkins to name a few. In addition, photographers may experiment with different colour schemes and degrees of illumination. Our findings unveil that varied colours and lighting options generate an advantage in hotel room quality, so hotel marketers may use their judgement to select the best balance.

The first suggestion for making a set of the hotel's exterior photos is to include images of nearby available tourist attractions in the hotel images portfolio. Next, the hotel entrance image taken from outside the street is a crux. In addition, it should contain a sign with the hotel's name and logo. This particular picture may imprint the customer's memory and make his journey and navigation towards the hotel more accessible. Similar to photographing hotel rooms, photographers may experiment with photoshoot hours as we found no difference in image performance depending on varying degrees of light.

Nevertheless, photographers must ensure sunny and unclouded weather if exterior hotel photos are taken in the daytime. Also, human absence in exterior photos improves the perception of the hotel. However, there is a peculiarity relevant to this rule. It is about bell captains wearing a uniform. Their presence near the hotel's entrance benefits the perception of the hotel. Then, it is worth experimenting with the angle of the photo composition. In this line, if a hotel offers premises of a swimming pool or terrace with a chill-out area on the roof, shots from elevated angles using a quadcopter can help create appealing hotel images. Finally, in the domain of the resort hotels, it is highly beneficial to exploit the picturesque beauty of the beach, sea views and the surrounding areas.

Concerning the images of the hotel lobby and welcoming zone, it is imperative to establish the presence of the hotel staff or hired models acting as receptionists photographed during their job routine. Wearing hotel uniforms is essential for these images. Then, it is highly advisable not to take a picture of the customers' queue awaiting the hotel check-in. However, a couple of hotel guests in a conversation with the hotel staff may make the lobby images more attractive. Second, the pivotal photography rule for shooting a hotel lobby is that a photographer must take these pictures from the corner of the welcome zone. By heeding this

rule, the human eye perceives the taken hotel lobby picture as visually more spacious. Besides, there is a chance to capture more elements in the angled photo of the hotel lobby. Third, photographers can shoot the welcome zone at any time of the day. Nevertheless, if hotel marketers are willing to emphasise the unique lobby illumination, nice-looking lamps and chandeliers, it is advisable to shoot in the dark hours of the day. Conversely, if large panoramic windows of the welcome zone require highlighting in the hotel marketing, thus, daytime is preferable for a photoshoot session. On top of that, finally, photographers have to include unique hotel lobby interior elements to accent them, as austere lobby images may not be effective (Reichek, 2016). These elements may comprise fancy furniture, paintings, or other installations appealing to the eye.

Social implications. The present research has several significant social implications. First, the proliferation of online digital photography substantiates the momentous cultural shift for humanity as humans have received the capability of benefiting from the latest technologies (Pauwels, 2008). In the domain of marketing, according to the findings of this study, a profuse online presence of hotels' digital images implies blurring communication frontiers between potential customers and the hotel. As a result, the priorly noted information asymmetry (Bergh et al., 2019) diminishes, designating customers' better awareness and building appropriate customer expectations for the hotel product. However, hotel marketers must mitigate embellishments in hotel image editing and production. It may create a non-realistic image of the hotel, delude hotel guests and engender higher customer expectations that cannot be met (Shams et al., 2020). In other words, online hotel digital images should make it possible for the hotels to conform to the WYSIWYG (What You See Is What You Get) imperative deemed beneficial to the hotel customers (Arora and Arora, 2017). Moreover, according to the most recent research, such an imperative facilitates the alleviation of misinformation that pertains to one of the most significant issues in modern society (Carrasco-Farré, 2022).

Second, the outcomes of the accomplished study point to specific hotel image aesthetics, composition and elements that precipitate hotel booking. In this vein, the hotel image aesthetics help customers accomplish sometimes tedious tasks relevant to the hotel choice. Thus, high-quality hotel photos generate customers' positive experiences on the web. According to the extant literature, the positive web experience increases satisfaction and improves customers' happiness and well-being (Cuesta-Valiño et al., 2021). In addition, photos of destinations placed on social media connect, restore and reactivate tourist destinations and services with potential customers. These online images may benefit host communities and their hotels (Santillán, 2010). At last, this study suggests an array of practical recommendations for hotel marketers elucidated above. When applied in the hotel management domain, these outlined recommendations will incite improvements in the marketing job execution leading to an increase in the hotel marketers' job satisfaction and commitment utterly, resulting in better business performance of the hotel (Kazakov et al., 2020; Singh and Shaurya, 2021).

Limitations and future research. The completed study is not without limitations. At first, the received model revealed an acceptable degree of 83% precision, but it needs further improvement to attain a higher model accuracy above 90%. Future studies may address such a limitation by employing a big data approach implying a scope on a more significant number of hotels, thus, collecting more hotel images and information on their bookings respectably. Second, the moderate model precision

obtained in this study is also due to the unavailability of the specialised open-source neural network, which was solely trained on the hotel photo images (Nanne et al., 2020). Third, this study utilised image vector pixels generated by Google Inception neural network as exogenous variables in the logistic regression model. Simultaneously, prior literature argues that hotel booking decision is a multifaceted notion driven by specific factors (El-Said, 2020). In this line, future research may benefit from comprising a set of control variables, e.g., hotel 'stars', quest rating, and room rate, to the log regression model developed under this study. Fourth, following the results of the sampling procedure application, this research was subjected to the tourist destination of Barcelona, impeding the generalisation of the findings. Succeeding studies may advance the field by determining the photo properties that precipitate hotel bookings in other destinations to build a base for more ample research results generalisation.

Finally, the fuzzy cognitive mapping method has known issues with accuracy as it solely relies on the researcher's perception and attitude. We thus recommend that future researchers consider the more advanced computer vision technologies currently recognised in data science and powered by object recognition and generative adversarial networks (GAN) (Saxena and Cao, 2021). We believe this study may mark an onset for the nascent research stream in hotel marketing literature that will further explore the capabilities of advancing computer vision technologies in hotel and tourism marketing.

Conclusions

The completed study expands the actual knowledge of the service product photo images' essence and function in marketing. It suggests an alternative approach to examining hotel online digital photo aesthetics, composition and content that influence online customer behaviour and precipitate hotel booking. A review of the prior literature has revealed the dominance of experimental and survey-based quantitative studies in investigating the effects of online images on customer booking intentions. Grounded in the extant body of research and capitalising on the opportunities brought by the latest technologies, this study develops a prediction model to analyse hotel photo pictures' power to drive customer booking decisions. We employed the pre-trained neural network to examine hotel image data to develop a prediction model which allows a small amount of hotel image data for analytical procedures. The neural network application output helped identify four significant dimensions of the photo aesthetics, namely, time of the photo shooting, angle, human presence and colour scheme.

This study also determined the specific values intrinsic to these dimensions precipitating the creation of high-quality hotel images that will effectively sell hotel bookings. The findings stemming from this research served as a basis to delineate the contributions to the marketing theory, evaluate the managerial implications of the study, and develop a set of practical recommendations for hotel marketers and photographers. If applied correctly, the suggested recommendations will enable hotel marketers to create practical briefings and precise technical tasks for the photographers. Finally, these recommendations would help hotel marketers and photographers to generate high-quality visual online content that improves customers' web experience and stimulates hotel bookings.

Data availability

The dataset can be viewed under the entry 'Online digital images of 4-star hotels in Barcelona' in the Harvard Dataverse repository, with the persistent identifier: doi:10.7910/DVN/XIX1JA. The

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The authors declare no competing interests.

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