Smart
Delivery

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Introduction:

Worldwide, the hospitality and tourism industry accounts for $7.6 trillion and creates 292 million jobs, however this industry is far from perfect. The field is plagued by a notoriously high employee turnover rate, due to factors such as low pay, lack of prospects, job dissatisfaction and poor work-life balance. The onset of COVID-19 has amplified these problems and accelerated the need for rapidly declining hotel services to adapt to the social-distancing guidelines. With the influx of Artificial Intelligence technology, a solution presents itself. There is currently a need within the industry that can potentially be fulfilled through the careful implementation of service robots. Conversely there may be a pushback by those who find Artificial Intelligence scary, or unnatural. This research paper aims to find whether the incorporation of robotics can revitalize the hospitality industry and push it forward, or if the changes would hurt profits due to push back from the public.

The SARS-CoV-2(Coronavirus or Covid-19) has swept earth at an alarming rate. As of the time of this writing, there have been over 12.8 million confirmed cases in the United States (US) alone, with a staggering 262,000+ deaths. As of the 3rd of June 2020, six out of ten hotel rooms remain vacant across the US. The Centers for Disease Control and Prevention (CDC)[1], reports that the Coronavirus can linger on surfaces and objects, which will naturally die within hours to days. Due to the unexpected introduction of this global pandemic, the hospitality industry has suffered huge losses, as people are more likely to stay at home, avoid travel and skepticism about the cleanliness of a hotel even when traveling all amalgamate into a perfect storm which has created a damaging impact on the profitability of the hospitality industry.

Perhaps now is the most ideal time for the hospitality industry and hotels to adopt a more technologically advanced and AI driven approach to hospitality. As it stands now there is going to be an uphill battle for recovery from this pandemic for most industries, but especially in hospitality. An innovative new solution to an old problem may be exactly what the industry needs to give it a boost into recovery and propel them even further than they were before the Coronavirus arose.

**Research Findings:**

Covid-19's Effects on the Industry:

Mohammad Reza Davahli and his team aimed to understand and reveal research on the effects of Covid-19 on the hospitality industry.[3] They conducted a systematic contemporary literature review to analyze and summarize research on the hospitality industry. Two research questions were at the forefront of the review, asking what aspects of the hospitality industry have been studied in accordance with the Covid-19 pandemic, as well as what research methodologies were used to determine the impact of Covid-19 on the hospitality industry. Research was conducted on Science Direct, Google Scholar, and Web of Science by utilizing keywords that covered broad aspects of the hospitality industry. Afterwards, the collection of articles found by those keywords were checked for duplicates, and the number was further reduced by removing articles with not enough relevant information and a lack of connection to the research questions. The articles of research were further classified by thematic groups that categorized the findings, be it survey collection, comparisons with previous health crisis, reports of the impact of Covid-19, measurements of those impacts, development of simulations and scenarios, or the propositions of management actions serving to reduce negative impacts.

Ultimately, the systematic literature review provided a wide range of data gathered using a variety of research methodologies. The main aspects of the hospitality industry covered in contemporary research were the recovery of the hospitality industry, market demand, revenue losses, and Covid-spreading patterns in the industry, which were identified in 19%, 18%, 16%, and 14% of the research papers, respectively. However, the review came with multiple limitations, such as the relevant timeframe, the limitation of where the research papers came from, and the choice of keywords that left out potentially relevant articles that nonetheless used none of the keywords utilized for the literature review.

Another study done by Yang Jiang and Jun Wen [5], wrote down a frontier study on the effects of Covid-19 on hotel management practices and market, aiming to stimulate knowledge of the developments of the hotel sector using a three-pronged agenda of research. The three branches were artificial intelligence & robotics, hygiene & cleanliness, and health & healthcare, and the research done would hopefully delve deeper into these branches to show how they apply to the ongoing crisis and can help hotels recover from said crisis. While the article is not exhaustive, it nonetheless indicates a wide number of effects that Covid-19 will have on the hotel industry through the lens of the three branches. There is a call for more effective strategies to help the hotel industry recover, be it boosting the confidence of guests, turning adversity into opportunity, or developing contingency plans for future health crisis. An expansive set of data on the effects of Covid-19 on the hospitality industry should invoke further study on the highlighted topics of interest, be it for more general knowledge collection or for developing a plan to use such knowledge to improve the recovery and sustainability of the hotel industry.

Professor Dr. Andreas Thams and his team highlight the effects of Covid-19 on the hospitality industry, including operational challenges and economic effects.[11] To do so, the paper goes through the importance of the tourism and hospitality industry on the world economy, the structure of the hospitality industry, and the potential measures that governments and

companies can take to reduce the severity of the impacts of Covid-19 on operation. A Ghanaian case-study was also conducted to supplement the mostly European-centered perspectives and statistics in the study, demonstrating how Covid-19 can drastically affect tourism, festivities, and hospitality in just three days. While the research could not exactly quantify the economic effects of Covid-19 on the tourism and hospitality industry, it could generally state that the industry would be affected for more than 10 months. Revenue drops higher than 30% are expected due to the shutdown of operations. Public institutions for tourism and hospitality are suggested to act swiftly with measures like tax cuts and reductions for hotels, debt cuts for institutions, increased access to loans backed by government institutions, and the avoidance of market biasing subsidies.

Monthly average daily rate of United States hotels from 2011 to 2020 (in U.S. dollars)
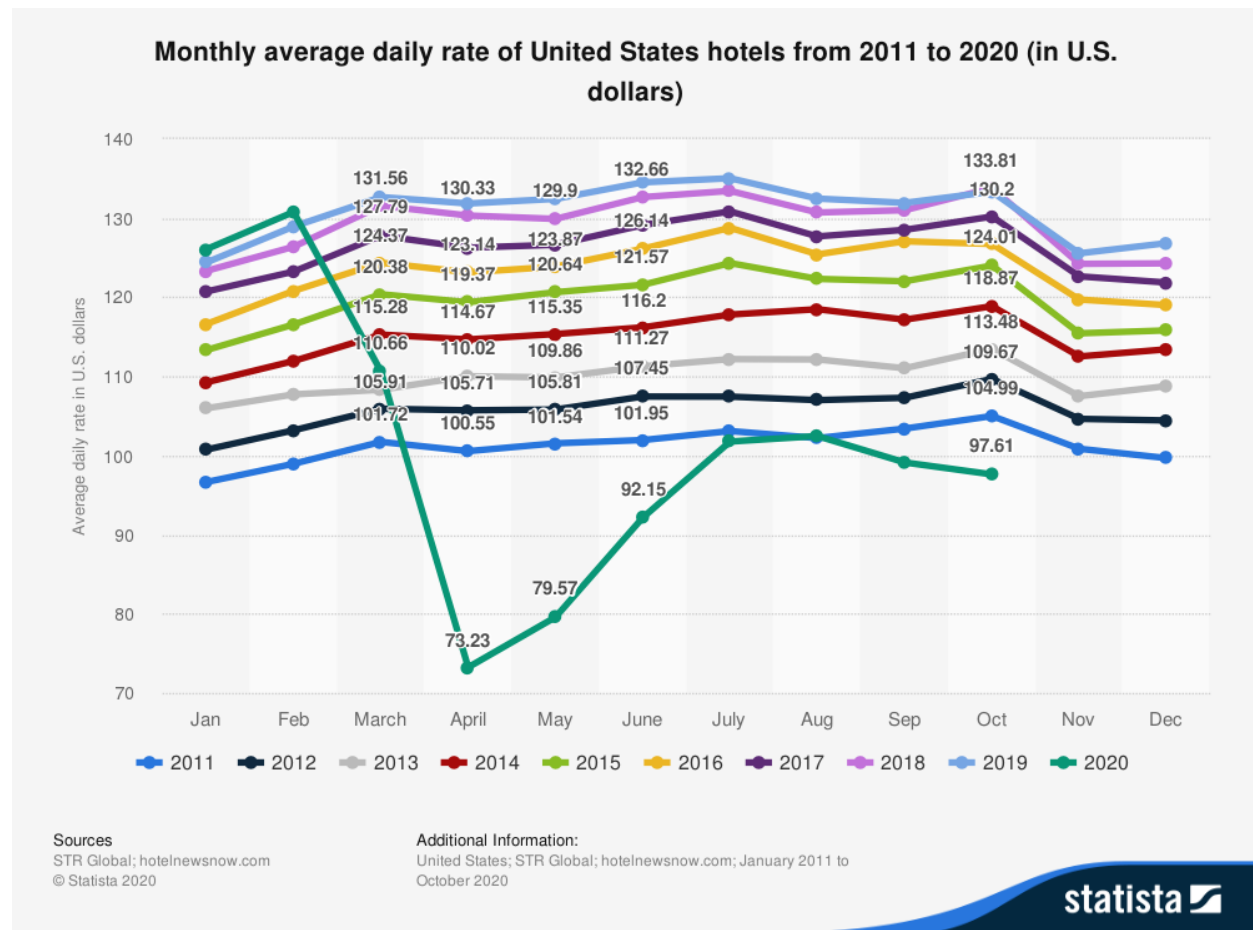
The graph above is visualizing the average daily rate for a hotel room for the past 10 years in the US. We can see that when the Covid-19 pandemic started with the US going into lockdown between March 2020 and April 2020, there was a groundbreaking dip in pricing for hotel rooms. Starting April 2019, the average price for a hotel room was $100.55, but due to the pandemic it dropped to $73.33 in April of 2020. This drop is a whopping 27% decrease in pricing from last year, which is a heavy hit. We can also see that this trend has lasted for a couple of months through the year of 2020, ultimately leading to another steady dip starting in September of 2020.

Artificial Intelligence:

Authors Georgina Lukanova and Galina Ilevia did a contemporary review of RAISA, robots, artificial intelligence, and service automation, as it is applied to hotel companies through a multitude of case-studies on hotel practices that involve these fields[6]. They also extrapolated potential capabilities for RAISA's use in the future. Both tasks were done through the lens of the "guest-cycle,"[6] a structure introduced by Michael Kasavanna in 1978. The structure details the relationship between guest and staff of a hotel across the guest's entire stay, and there are five stages: Pre-Arrival, Arrival, Stay, Departure, and Assessment. For each stage, research was done to determine theoretically how robots and AI could be implemented to serve the duties related to that stage, and following the theoretical there would be an overview of demonstrated applications of RAISA in real hotels, along with the reactions to the technology by guests and staff.

Ultimately, the review finds the application of service robots to be highly controversial. While robots and AI have numerous benefits across many stages in the guest-cycle, customers still want a more human element to their visit while employees are wary of the changes that a system of robotics may bring to their jobs. Based on the findings, both guests and employees still see robots as less of a necessity and more of an attraction, meaning that their application in the hospitality industry will be a slower process than that of AI or mobile technologies. While robots can make tasks like housekeeping, security, and maintenance more efficient, they will need assistance by human staff when working on tasks that involve human contact. Robots are unlikely to overtake the jobs of human employees and more likely assist human workers.

In the Tech Directions publication[8], Pierce wrote a small article talking about a hotel located outside the Huis Ten Bosch Amusement Park in Nagasaki, Japan called The Henn-na Hotel. The article proposed a very important question about how fast is technology developing to the point where AI would become a dangerous competitor to the current working class? Continuing with the article with evidence and examples of how robots are being used in this hotel, their benefits, and future.

Implementation Case Studies:

Some of the amazing advancements Pierce discussed in his article was the fact that these robots "Used electronics to simulate the motion and actions of living organisms"[8]. Robotic design has come a long way, with it now allowing them to perform tasks only humans were able to do, and robots can be modeled or built to look like a human, animal, or inanimate objects. To add to the list a few tasks the robots were able to do at this hotel are voice recognition / synthesizer, customer support, front desk attendant, posters, room cleaning, and the list goes on.

All these advantages are only surface level proof that robots should be more utilized in the workforce. As stated in the article, "Business and industry leaders and the stock market all recognize the fact that profits go up as labor costs go down when people are replaced by machines." [8] Not only are robots helping the customers, but they are also helping hotels financially because of their ability to work 24/7, with no pay.

Following up with the recent times of 2020, robotics can help fight against the Covid-19. This is due to the robots not being human, or ever having to touch the client / resident. As stated before, Covid-19 can spread through human contact with the germs being spread through the air or on surfaces. But with receptions having "camera eyes that send a video feed to a computer that uses facial recognition to personalize the robot's interaction with each guest" [8], you will not have to ever come in contact with the staff.

Ivanox, Webster, and Berezina chose to elaborate more on how robotics and service automation is used in the travel, tourism, and hospitality industries, as well as how these industries could adopt robotics and automation in the future [4]. The paper also highlights the challenges that companies may face when attempting to adopt service automation and robots into service. Robots have already seen minor uses in hotels, restaurants, theme and amusement parks, Museums, car rentals, travel agencies, airports, and meeting events. Overall, the rising capabilities of robots along with decreased purchase and maintenance costs means that robots may see increased use in the hospitality industry in the future as a reliable alternative to human employees. However, not all services in the industry will benefit from automation and robotics in the same way. Factors like economic efficiency, company competitiveness, and customer experience will determine whether robotics will be implemented or not. The use of automation and robots has been scarce in the hospitality industry, so more research will need to be done to find the best path of implementation for these new technologies.

Experts predict that the introduction of AI and robotics into the workforce will greatly impact the way that society views work from a structural and conditional perspective. [9] One of the benefits of this system is that computers and robots are able to learn from human interaction. This learning can come in the form of employees who work alongside the AI, and train it to accomplish tasks, however AI can also learn simply by completing tasks for customers. The AI can learn the habits and preferences of individuals as well as common preferences among groups of people especially in the hospitality industry where customer interaction and service is a routine task on a day-to-day basis. This allows the AI to form profiles for individuals and learn their preferences, allowing the hotel to track these patterns and offer their patrons deals that are suited to their needs. This is something that the hospitality industry could greatly benefit from, allowing their systems to recognize customers and greet them by name using facial recognition, but to predict when a customer will request a certain service, and cutting down on the amount of waiting time between a request and the completion of the request.

Robotic systems already in place in the hospitality industry, such as chatbots for assistance and maid-bots to handle the daily housekeeping services, have been found to reduce the number of errors, improve the speed of decision making, and keep track of customers and tasks better than their human counterparts. [9] In addition, when working in conjunction with human employees robotic systems have been found to enhance the performance of human employees, without impacting the employee turnover. All this together results in an overall higher service quality within the industry, which when considering the hospitality industry is a factor that leads to increased profitability.

The AI systems would be greatly beneficial to the industry. There are two important aspects which would allow for the integration of AI more seamlessly into the hospitality

industry. One important aspect would be the integration of AI which is focused on supplementing human efforts and assisting employees to increase productivity and accuracy of tasks. The second would be an integrated system where systems within individual hotels can communicate and collaborate with each other, and in the process increase information gain everywhere.

Even if implemented in a way that allows AI to supplement human employees, rather than replace them some believe that the introduction of robots would increase the already high employee turnover rate. Employees may view their AI counterparts as their own replacement in the future, rather than as a tool to assist them in their current tasks.

The Public View

In *Consumer Evaluation of Hotel Service Robots*, the researchers aimed to do two things: First, they wanted to learn how robots currently being used in hotel service are being received by the public, including the possible incentive for more robots. Second, they wanted to figure out how customers react to different types of hotel service robots, testing for which characteristics elicited the most positive reactions from consumers.[12] There were two tests done in service of this goal, both of which utilized at least one image of the two robots and one video of the two robots in action. The first robot, NAO, was an anthropomorphic robot that worked the check-in at the front desk, while the second robot, Relay, was a cylindrical robot that delivered snacks to a guest room. The first test involved a large-scale online survey where consumers evaluated their own responses to the robots. A second test used eye-trackers, GSR skin-conductance sensors, Heart-Rate monitors, and even the AFFDEX facial coding system to track various immediate emotional reactions to demonstrations of the two robots.

From these tests, the researchers concluded that anthropomorphism, perceived intelligence, and perceived safety are the factors that most affected consumers' positive reactions and inducement to adopt service robots. That observation is proven by the test results, which demonstrate that anthropomorphism was positively valued due to the reactions of consumers to the human-like NAO robot. NAO's ability to process payments and reservations while instructing guests on the use of their room key demonstrates both intelligence and perceived safety, which further boosted NAO's popularity in the tests. Intelligence is also responsible for Relay's positive emotional reception, though its non-human design and perceived lack of safety led to its overall positivity being lower than that of NAO. The researchers suggest that more human features, especially the face for which NAO was receiving much attention, could lead to better reception for more hotel service robots in the future.

A survey done by Tata Consultancy Services (TCS) found that 85 percent of the travel & hospitality already use Artificial Intelligence in some capacity within their business.[10] In addition 80 percent of customers would choose self-service technologies over services in which they interact with a real human if the option were available. With so many people preferring to interact with a robotic system run by an AI rather than human employees, it is important now more than ever for the hospitality industry to implement those choices.

Technology drive assistants, or robots, are currently using the Internet of Things technology to accomplish tasks such as turning on bedroom lights, turning off the TV, and handling guests checking into a hotel. Robot receptionists have become more and more common as time goes on. Even room service aspects have been handled in some hotels, allowing for room cleaning, and housekeeping services, and delivering pillows, blankets and food and drink to customers directly in their room. Recent surveys have shown that "Smart hospitality" is expected to grow over 25 percent by 2021.

Although there are many benefits to the introduction of AI there are some downsides. One problem is the limitation of usage by those who are unfamiliar or even afraid of technology. They may be apprehensive or intimidated by these AI machines, preferring interaction with a live human. This is something which experts predict will be overcome as innovative solutions and emerging technologies continue to become more prevalent. Another issue is protection against malware. Security measures can be stringent, but human hackers can be quite ingenious and sophisticated, finding loopholes and back doors into systems and creating mayhem. This is a real concern for these AI systems, especially when they are customer-facing technologies which may create an unpleasant situation if they are manipulated in some way. One final hurdle that will need to be overcome is the upfront cost of implementing these systems. Although large hotel chains can spend the money to implement these systems into their hotels, a small service provider cannot afford these technologies. This may lead to a situation where the gap between the large hotel chains and the independent hotel owners grows even larger.

Future Plans

In the coming semesters, the team hopes to build tech demos of a new robotics system, which can be utilized in any hotel. Here, the team can visually display to potential customers how robots can make jobs easier, faster, and more cost efficient. Showing the speed and accuracy is going to be key to get people on board for robotics, and the safety features that come along with them. The first line up of robotic systems will be a room service system, in which the robot can be loaded with a variety of objects and deliver them to the customers.

Conclusion

Based on the findings presented in this paper, smart-delivery robots have numerous potentials uses in speeding up the recovery of the hotel industry from Covid-19, while bolstering that industry long after the pandemic ends. Research was conducted through an extensive review of scholarly journals that discuss applications of robotics in hotels or study robots currently being used in the industry. From there, researchers can gauge audience perceptions of hotel robotics and how these perceptions can be changed with innovation trajectories.

Further research can be done in the field of hospitality robotics with a couple of methods. First, people can pay close attention to the development of the field of robotics overall to see if any new developments can be applied to robots in the hospitality industry. In addition, people can watch service robots that are in use in places like Henn-na Hotel and use their data to suggest further improvements and development trajectories.

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