Service robots in online reviews: Online robotic discourse

Service Robots in Online Reviews:

An empirical study of online robotic discourse

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1. Introduction

Humans and machines increasingly interact with each other to co-create services (Huang & Rust, 2018) and value in service industries (Mariani & Borghi, 2019). Progress in robotics and artificial intelligence has allowed machines to conduct gradually more complex tasks (Wirtz et al., 2018). Due to their physical embodiment and their increased interaction with humans, service robots can be perceived as social agents able to redefine service encounters (Larivière et al., 2017). This is of special interest in the tourism and hospitality sector, where the deployment of service robots is on the rise, promising to disrupt the nature of services and customers' experience (Tussyadiah, 2020).

Yet, to date, scholarly efforts in the tourism and hospitality domain have been rather fragmented and highly conceptual, leaving aside empirical research designs (Ivanov et al., 2019). According to Tussyadiah (2020) relatively little is known about the assessment of the impacts of intelligent automation on tourism, and more longitudinal studies are needed (Ivanov et al., 2019) to make sense of the influence of service robots after consumption (Lu et al., 2020). To address the aforementioned call for research, consistently with Godes and Mayzlin (2004), this work builds on electronic word-of-mouth (eWOM) research and theorizations to capture and track the diffusion of innovation (Rogers, 2003) by means of online conversations.

Previous research has suggested that customers' discourse in online reviews (ORs) is critical upon and immediately after new product introductions to build consumers' awareness (Godes & Mayzlin, 2004) and can be leveraged to track the popularity of a product or service feature over time (Chevalier & Mayzlin, 2006). Therefore, we argue that online consumers' discourse can be a useful means to assess whether the awareness about service robots goes beyond a mere "*novelty effect*" (Roehrich, 2004). Indeed, if the novelty effect associated with service robots is the only mechanism in place, robots' popularity would rapidly fade away, suggesting that robots are not a distinctive factor in the evaluation of the service offering. As service robots have been introduced in hospitality services quite recently, there is an urgent need to explore how and if customers' discourse revolving around them is evolving over time from both a diffusion and adoption of innovation (Rodgers, 2003) and a human-robot interaction theoretical perspectives (Newell & Card, 1985; Tussyadiah, 2020).

To bridge this research gap, this study aims to provide preliminary insights on the following research question: *Are service robots becoming an increasingly distinctive and popular feature in hotel-related eWOM beyond their introduction?* To this end, we develop the concept of *online robotic discourse* - defined as eWOM in online reviews mentioning explicitly service robots deployed in hospitality services - to monitor the diffusion (Godes & Mayzlin, 2004) and adoption (Dellarocas et al., 2007) of service robots over time. This is critical from both a consumer perspective to understand the relevance of service robots in consumers' evaluation of service experiences, and from a company perspective to shed light on the outcomes of innovation strategies. Accordingly, this work contributes to the emerging research stream at the intersection of eWOM and service robots (Tung & Au, 2018) with the purpose of using e-WOM to track diffusion of innovation (Rogers, 2003) and improve our understanding of the impacts of intelligent automation in tourism (Tussyadiah, 2020).

2. Methodology

Based on a data science approach (Bi et al., 2019), we analyse quantitatively the distribution of ORs covering service robots over time and across a wide range of hotels that have adopted robots in their frontline services. Firstly, we conducted an online research on the most popular search engine worldwide – Google – using keywords related to different types of robots in the hotel domain, combined with the search term "*hotel*", to detect leading hotels adopting service robots in their operations. This allowed us to identify 19 international hotels, as clear from the supplementary materials. Secondly, we performed a further research for each hotel, triangulating content on their website, company news, social media accounts and company reports to identify the introduction date and the name of the robot. Thirdly, we retrieved the entire population of TripAdvisor ORs for the 19 hotels identified in the exploratory research until October 2019. The automatic translation function of TripAdvisor was used to homogenise the language of the retrieved content to English. Accordingly, we obtained a total sample of 49,209 reviews of which 27,433 were written after the introduction of service robots. Finally, to compare the distribution of robot-related vs. not robot-related ORs, we employed both mean (Welch two samples t-test) and median (Mann-Whitney-Wilcoxon test) statistical tests.

3. Findings

To capture hotel customers' online discourse related to service robots, we organized the information about TripAdvisor ORs after the introduction of service robots (N=27,433) into two subsamples: one including all the robot-related ORs (N=3,627) and the other encompassing all the other reviews (N=23,806). The former were named "*robot-related online reviews*" because they explicitly referred to the robotic service encounters as they either contained the keyword "*robot*" or the specific name of the robot in the full text of the retrieved review.

3.1 Trend of online robotic discourse

We examined the share of robot-related ORs in a longitudinal perspective (Myers et al., 2010), analysing the cumulative percentage of robot-related ORs for each hotel in the sample starting from the first month after the introduction of service robots in the companies' operations. As is clear from Figure 1, there are differentiated trends of *online robotic discourse* across the 19 different hotels; however, the average trend (the grey dotted line) - calculated using the simple mean among the analysed businesses - is increasing over time. In the first month after the introduction of service robots, on average 13.5% of ORs contained the evaluation of robotic service encounters. This figure raises up to 19.2% after 18 months, meaning that almost one out of five reviewers included service robots in the judgement of their stay. This result suggests that service robots are not merely linked to a novelty effect, but rather that after their introduction they have become a distinctive factor in the evaluation of the service experience. Moreover, performing a series of Friedman's Chi-Square tests we found statistically significant differences in the entire sample (χ^2=312.19, p<0.001) and also across hotels having introduced only one type of robot (χ^2=236.23, p<0.001). This corroborates the idea that the way the hotel designs the service experience revolving around service robots matters towards the inclusion of service robots in the evaluation of the stay (Ivanov et al., 2019). Furthermore, aggregating hotels based on the two main service robots identified in the dataset (i.e., robot butler and concierge), the Mann-Whitney-Wilcoxon test showed a significant difference between the samples (z=5.14, p<0.001). Indeed, robot butlers seem to have a higher impact in terms of mentions (mean=17.58%) than concierge robots

(mean=0.63%) on the online robotic discourse. This could be due to robot butlers being more likely than concierge robots to co-create customized experiences (Tung & Au, 2018).

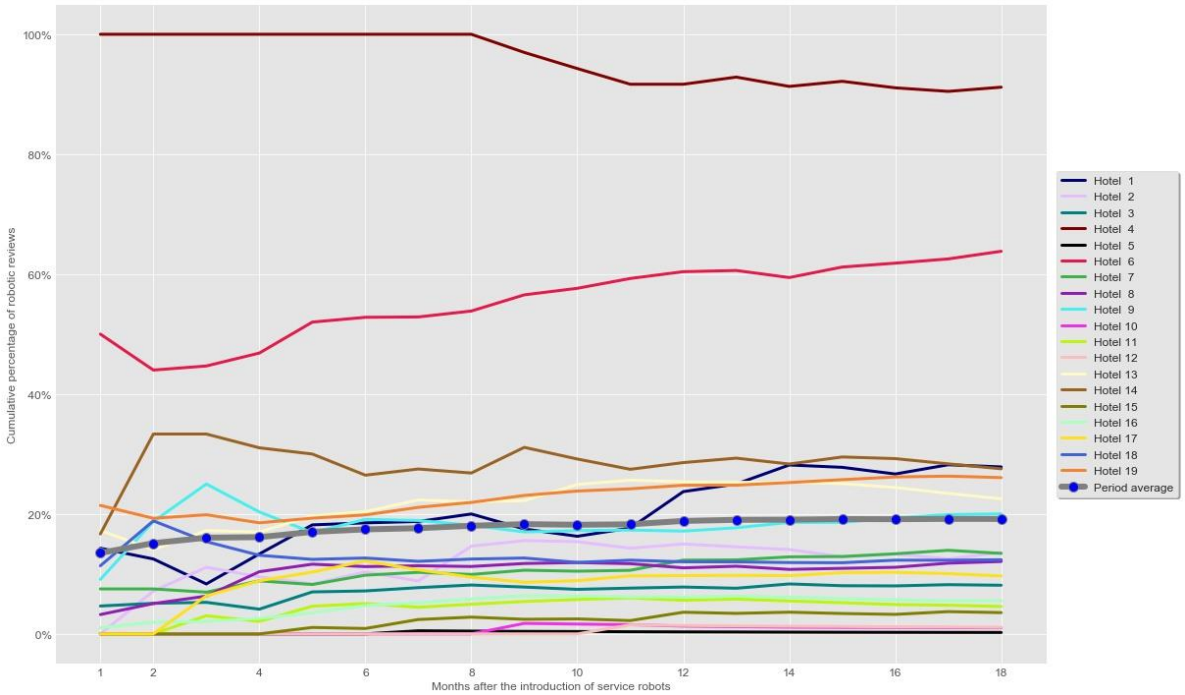

Figure 1. Trend of online robotic discourse in eWOM in the first 18 months

3.2 Differences in robot vs. not robot-related ORs

Comparing the two subsamples a wide range of statistically significant differences can be detected (see Table 1).

Table 1
Comparison of robot vs. not robot-related ORs

	Total Sample (N=27,433)		**Robot-related ORs** (N=3,627)		**Not robot-related ORs** (N=23,806)		**t-test**	**Mann-Whitney-Wilcoxon test**
	Mean	SD	Mean	SD	Mean	SD	t	$Wx10^7$
Valence	4.264	1.002	4.356	0.871	4.250	1.020	6.699^{***}	4.469^{***}
Review_Images	0.294	0.876	0.497	1.097	0.263	0.833	12.316^{***}	4.711^{***}
Review_Length (in words)	109.384	105.696	151.738	145.672	102.943	96.592	19.570^{***}	5.421^{***}
Log(Reviewer Experience)	2.359	1.859	2.760	1.907	2.298	1.844	13.721^{***}	4.922^{***}

First, robot-related ORs display higher ratings (4.356) than not robot-related ORs (4.250). The reason might be that travellers are curious about and positively impressed by the innovation brought about by robots (Tung & Au, 2018). Second, reviewers reporting service robots are keener to embed images in their ORs. An explanation of this finding could be that

reviewers might find it easier to describe a robot-related visual content or they might want to provide further evidence of robots' presence using photos in online communities.

Third, focusing on the textual content, robot-related ORs are significantly longer than not robot-related ORs, with the former consisting on average of approximately 150 words and the latter of around 103 words. We might infer that aspects related to robots are normally covered by more detailed reviews that report more information on different hospitality service attributes. Finally, it seems that more experienced reviewers are more prone to mention service robots than their counterparts. Since volume can be perceived as a proxy of awareness (Godes & Mayzlin, 2004) in the introduction phase, more active and experienced reviewers might know in advance about the presence of the robot and therefore we expect that their experience will be more influenced by the robotic service encounter.

4. Conclusions

This exploratory study reveals that service robots are increasingly becoming a recurrent and popular feature in the evaluation of the hotel stay, beyond a mere novelty effect. This suggests that service robots are perceived as valuable not only by travellers interested in technological innovation, but also by an increasing number of service customers. Additionally, it corroborates the idea that service robots distinctively impact the tourist experience as we found statistically significant differences between the robot-related and not robot-related samples of ORs. Nonetheless, heterogeneity in reviewing behaviours exists across the hotels and robots reviewed.

By deploying the novel concept of *online robotic discourse*, we contribute to the conceptual and methodological development of e-WOM as a means to capture and track the diffusion of innovation involving service robots. We suggest that tourism and hospitality researchers could use online conversations (Godes & Mayzlin, 2004) about robots and the related analytics to (1) inform research pertaining to the diffusion and adoption of innovation (Rogers, 2003) involving service robots; (2) inform research related to human-robot interactions (Newell & Card, 1985) in the tourism context (Tussyadiah, 2020). As far as (1) is concerned, as different customer groups adopt differently innovation and the adoption behaviours change over time, scholars could use *online robotic discourse* to generate insights on robots' diffusion and adoption across different categories of travellers, possibly by also controlling for demographics that in many cases can be inferred from ORs. Furthermore, the analysis of *online robotic discourse* can help researchers generate knowledge about tourism companies' introduction, adoption, and deployment processes of service robots that might be relevant to optimize companies' operations. As far as (2) is concerned, *online robotic discourse* can aid scholars to understand how and to what extent service robots drive and influence customers' evaluations of (and satisfaction with) tourism and hospitality services, whereby evaluation can be captured by means of OR ratings. Furthermore, online robotic discourse can assist researchers interested in analysing service encounters (Larivière et al., 2017) allowing them to gain knowledge about robots-enabled tourism and hospitality service encounters. Finally, and related to the previous point, *online robotic discourse* would help researchers disentangle the assessment of intelligent automation in tourism and hospitality services.

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Appendix A. Supplementary data

A. Retrieved Hotels

Table 1
Summary of hotels that introduced robots in their frontline operations

Hotel ID	Hotel Continent	Type of Robot
Hotel 1	North America	butler
Hotel 2	North America	butler
Hotel 3	North America	butler
Hotel 4	Asia	front desk, luggage, room assistant, concierge, butler
Hotel 5	North America	concierge
Hotel 6	North America	butler
Hotel 7	Asia	butler
Hotel 8	North America	butler
Hotel 9	Asia	butler, chef
Hotel 10	Europe	concierge
Hotel 11	Asia	butler
Hotel 12	North America	security
Hotel 13	North America	butler
Hotel 14	North America	butler, luggage, concierge
Hotel 15	Asia	butler
Hotel 16	North America	butler
Hotel 17	North America	butler
Hotel 18	North America	luggage
Hotel 19	Asia	butler

We conducted an online research on the most popular search engine worldwide – Google – using keywords related to different types of robots in the hotel domain (see Ivanov et al., 2017) combined with the search term "*hotel*", to detect leading hotels adopting service robots in their operations.

Ivanov, S., Webster, C., & Berezina, K. (2017). Adoption of robots and service automation by tourism and hospitality companies. *Revista Turismo & Desenvolvimento*, 27/28, 1501-1517

B. Analysis of volume of ORs for each of the retrieved hotel – entire sample

Table 2
Volume of ORs related to hotels that integrated robots into their operations

Hotel ID	Share of robot-related ORs after the robot introduction
Hotel 1	20.18%
Hotel 2	11.18%
Hotel 3	6.81%
Hotel 4	83.75%
Hotel 5	0.29%
Hotel 6	65.36%
Hotel 7	14.64%
Hotel 8	12.68%
Hotel 9	23.30%
Hotel 10	0.74%
Hotel 11	3.95%
Hotel 12	1.09%
Hotel 13	19.33%
Hotel 14	25.00%
Hotel 15	3.45%
Hotel 16	5.53%
Hotel 17	8.54%
Hotel 18	10.50%
Hotel 19	26.49%
Overall Total	**13.2%**

Robustness check ORs written in English

C. Trend of online robotic discourse sample English ORs

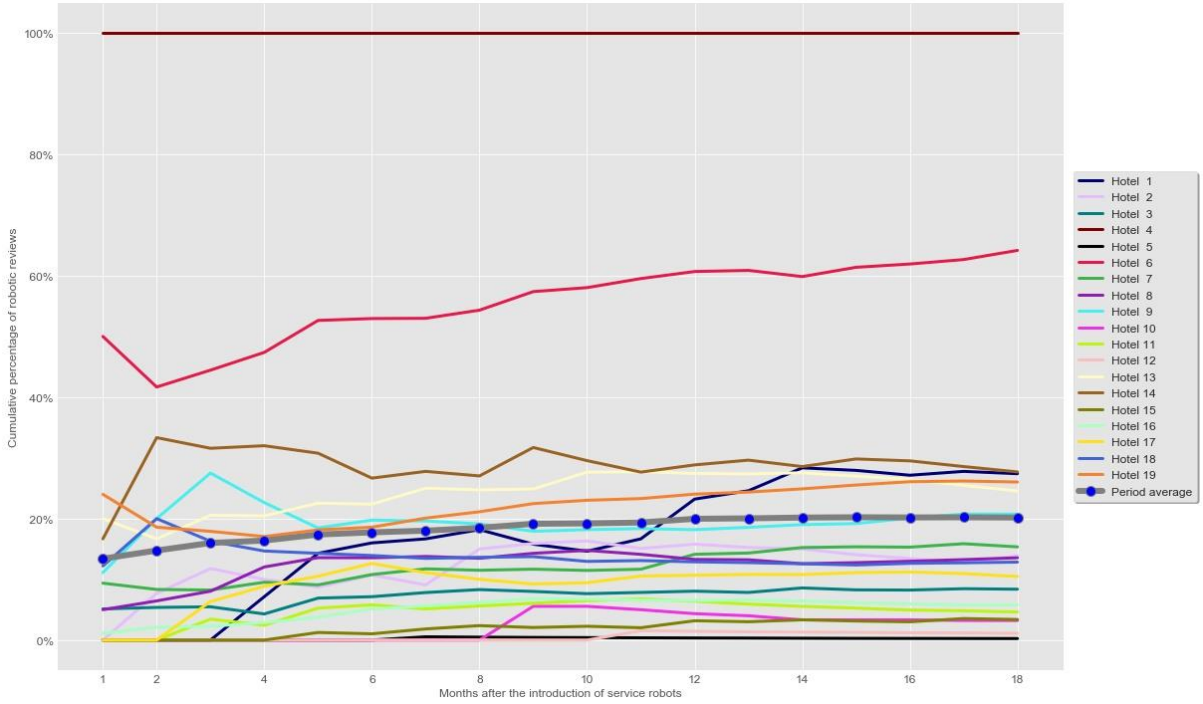

Figure 2. Trend of online robotic discourse in eWOM in the first 18 months after service robots' introduction English sample

The graph depicts approximately the same trends of the overall sample, confirming the findings of the research note.

Performing a series of Friedman's Chi-Square tests we found statistically significant differences in the entire sample (χ^2= 301.836,p<0.001) and also across hotels having introduced only one type of robot (χ^2= 221.254,p<0.001). Furthermore, aggregating hotels based on the two main service robots identified in the dataset (i.e., robot butler and concierge), the Mann-Whitney-Wilcoxon test showed a significant difference between the samples (*z*= 5.137,p<0.001). Robot butlers seem to have a higher impact in terms of mentions (mean=18.15%) than concierge robots (mean=1.73%) on the online robotic discourse. These findings further confirm the results of the research note.

D. Differences in robot vs. not robot-related ORs sample of English ORs

Table 3
Comparison of sub-distributions of robot vs. not robot-related ORs English subsample

	Total Sample (N = 21,616)		**Robot-related ORs** (N = 2,959)		**Not robot-related ORs** (N = 18,657)		**t-test**	**Mann-Whitney-Wilcoxon test**
	Mean	SD	Mean	SD	Mean	SD	t	W x 10^7
Valence	4.259	1.035	4.39	0.868	4.238	1.057	8.559***	2.908***
Review Images	0.247	0.805	0.433	1.029	0.218	0.759	10.922***	2.995***
Review Length (in words)	111.997	110.603	152.14	149.048	105.631	101.758	16.379***	3.399***
Log(Reviewer Experience)	2.175	1.869	2.604	1.913	2.107	1.853	13.181***	3.175***

All the results are in line with the main findings provided in the research note based on the overall sample of online review.