Service Robotics in hospitality

developing business model guidelines for a service robotic startup by understanding what is driving and influencing adoption of robots in hotels

Master Thesis - Management of Technology 2018

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Colophon

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In partial fulfilment of the requirements for the degree of

Master of Science

in Management of Technology

at Delft University of Technology,
to be defended publicly on 11th July 2018

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Contents

List of Figures

List of Tables

Executive Summary

Many market research agencies and consulting firms claim the robotics service and consumer market is about to boom. Market reports show there's a massive, untapped market for robots to be used in commercial spaces such as hotels, restaurants, fast-foods and cruise ships. These spaces could serve as a great stepping stone on the path toward general-purpose home robots by driving scale, volume, and capabilities. However, there is a significant research gap in this field: only few studies are available on the introduction, adoption and diffusion of service robotics technologies in the hospitality industry.

Tactile Robots (TR) is a high-tech startup based in Lecce, Italy, whose go to market strategy is to introduce its autonomous robots for indoor delivery in hotels for performing hotel room service. On one hand, nothing or only few is known regarding what is driving adoption of robotics technologies in hospitality and about which are the factors that are influencing adoption. On the other hand, Tactile Robots lacks adequate knowledge about its potential customers and the condition under which they are willing to be delivered value by TR's innovative robotic solution.

The aim of this research is to give recommendations about the design of a viable business model for Tactile Robots by investigating the drivers of adoption of service robotics technology in hospitality industry, together with factors that are influencing adoption. Traditional Business Model (BM) design practices and BM ontologies fail in taking into account contextual factors and actors outside the firm specific value chain. In this work, we propose a novel approach to business modeling which, through a first step of empirical research involving different external stakeholders, identifies technology adoption drivers and factors under the architecture of the theoretical Technology Organization and Environment(TOE) framework. Findings are then organized to structure four case studies that represent the approach with potential customers. Multiple case study analysis provides in depth insights needed to give informed recommendations for business model design for Tactile Robots. The set of recommendations touches primarily three out of nine building blocks of the chosen business model ontology, Business Model Canvas, namely: Target customers, Value proposition and revenue model.

Research showed how, in order for service robotics solutions to be successfully introduced to the hospitality market, value propositions should address predominantly the customer facing side of

hospitality business. Unlike for industrial settings, robots are not likely to be adopted by players in hospitality for the only purpose of cost reduction and enhanced productivity. They, instead, need to bring significant value to the guest by augmenting the service or providing a superior experience. Furthermore, well renowned international innovative hotel chains seem to be the most suitable target segment for service robotics applications. Finally, due to stringent financial factors, it is advisable to sell robots on a leasing model which allow hoteliers to minimize initial investment and future switching costs.

This study is the first that research business model design for service robotics startup entering the hospitality industry. Further research is required to validate the factors that are influencing adoption of robots in hotels and to find the relative contribution of these factors to adoption decisions.

Part One

1. Introduction

Many market research agencies and consulting firms report that the robotics service and consumer market is about to boom. Research from Marketsandmarkets[33], BCG and Tractica[58] forecasts a spending in the sector of over $46 billion in 2025, whith a Cumulative Average Growth Rate (CAGR) of 18%[21]. Startups and R&D interests are significantly increasing in this field: almost 75% of new robotics startups are tackling the service robot industry. Within this 75%, a 32% is distributed into unmanned devices for filming, marketing, delivery, security, military and mobile robots for various uses. Moreover, research shows there's a massive, untapped market for robots to be used in commercial spaces such as hotels, hospitals, offices, and retail stores. These spaces could serve as a great stepping stone on the path toward general-purpose home robots by driving scale, volume, and capabilities.[59]

Tactile Robots (TR) is a high-tech startup born in November 2016 in Lecce, Italy, whose goal is to exploit the double digit CAGR potential of the service robotics industry positioning itself within the market niche of autonomous robots for indoor delivery in public spaces. TR designs and commercializes safe and user-friendly autonomous robots for automated delivery of food, drinks and goods in indoor crowded environments. Tactile Robot's products are suitable for multiple applications and It is possible to formulate specific use case and tailor-made value propositions for the adoption of Tactile Robot's products in several different public indoor spaces. Hospitals could use the robot to perform deliveries of meals and or medicines inside their facilities, while inside airports, shopping malls, canteens, restaurants and hotels, the robot could be used to deliver food, drinks and small goods to customers. Also industrial production facilities represent a viable use case scenario where the robot could deliver, in addition to food and meals, small tools or items needed by the workers in different points inside the factory.

Before the incorporation of the company and in the first months of operations, a first effort of market validation has been made by the startup founders that had set the basis for the conception and design of the first fully functional prototype: an autonomous robot to be used in hotels for performing automated hotel room service deliveries. In section 1.1 the choice of the beachhead market will be explained and motivated.

1.1 Research Problems

A research project is now being set up by Tactile Robots with the aim to tackle the following problem:

Despite a first preliminary effort of market and customer validation, Tactile Robots still lacks a complete understanding of the requirements of the users, customers and of the conditions under which they are willing to be delivered value by the company, together with a lack of clarity regarding the conditions under which Tactile Robots itself is able to deliver value to stakeholders and to capture value from them.

Tactile Robots is approaching a phase in which there is the need to involve potential customers and stakeholders more closely not only in the design of the actual product, but even more crucial is becoming the necessity to couple the product development phase to the development of the business. Tactile Robots still lacks a well-defined architecture of the business that structures the value creation process, the channels and methods to deliver this value to stakeholders and the mechanisms that capture part of this value. We see this as a Business model problem and the knowledge resulting from the research will be used to give recommendations about the design a viable business model for the company.

In order to provide a better understanding of the context of the problem, it is useful to describe Tactile Robots' proprietary technology and the product that is now being designed by the startup, together with the chosen application of the technology and its potential market.

Technology and product

Public indoor environments such as hospitals, hotels, airports or shopping malls are dynamic, complex and populated spaces. A review of the state of the art and existing autonomous indoor robots in the market reveals that they are not safe and interactive enough to operate in such dynamic crowded places[49]. In fact, the obstacle avoidance systems of mobile robots are based on complex algorithms and sensors which are subject to failure. Therefore, the risk of collision with objects and people is still significant in case of narrow and crowded places. The existing indoor delivery robots are too large to pass through narrow spaces. Furthermore, they are not able of understanding the human will, so they may get stuck in the middle of a corridor or of an elevator and prevent people from passing for example. This makes indoor delivery robots perceived as an obstacle by a part of the users, especially by elderly people, limiting the spread of existing robotic solutions in public indoor environments. Tactile Robots solves the above-mentioned technical challenges and enables robots to actually serve humans even in narrow and crowded environments by making mobile wheeled robots behave as if they were as light as an empty box. This is possible thanks to Tactile Robots' patented solution: a soft, shock-absorbing, pressure-sensitive skin applied to the external surface of the mobile robot introducing intrinsic safety and intuitive and ergonomic physical interaction. The simple and robust behavior enabled by Tactile Robot's skin makes the robot fully safe: if the collision avoidance system fails and the robot gets in contact with the obstacle, the robot feels the presence of the obstacle and stops before causing damages. Tactile Robots' technology also provides an extremely intuitive and effortless interface: the user can move the robot by a light nudge in the desired direction, regardless of the weight of the transported load. Furthermore, it is not required to trigger a compliant mode: the user can nudge the robot also when it is navigating to its destination. The proposed technology is simple and low-cost, therefore it is suitable for integration into commercial products.

Several experiments of interaction have been performed using a first Minimum Viable Product (MVP) involving people of different ages and of both sex. All the users have shown an immediate capability of moving the robot to the desired position and they have declared to enjoy the interaction, thus providing a validating proof of the concept that allowed TR to start the design of the first fully functional prototype.

As mentioned, Tactile Robots' solution is potentially valuable for several applications. After a first market validation effort, the startup has decided to initially focus on the delivery of food, drinks and goods in hotels.

Application and market

In order to narrow down the focus on the units of analysis of our research, it is useful to provide a more detailed and motivated description regarding the choices that Tactile Robots has done with respect the field of application and the beachhead market.
The initial market validation phase carried out by Tactile Robots before starting the design phase of the first proof-of-product prototype, led to the definition of a first beachhead market niche: hospitality industry.
Hotels are facing new challenges to attract and retain customers while lowering their labor costs. They need to be able to innovate and complete their service in order to defend their position against new platforms that are reshaping the industry such as AirBnB ecc. That's why hotels, as they proved to Tactile Robots, are strongly receptive to new concepts and opportunities aimed at improving their positioning, image and level of customer care.

1.1.1 Practical problem

Robots have been around for a while, especially in manufacturing or generally in industrial settings. Their adoption in these fields has been driven mostly by the need to cut costs, increase productivity and enhance quality of products. The adoption and diffusion of robotics and automation over the last 50 years, together with the digitalization of manufacturing industry has led to a new era of production which has massively affected economy and society as a whole.
On the other hand, service robots are completely new to hospitality industry, they have just started to be adopted in only very few hotels worldwide with different use cases and scenarios. The business of hospitality is completely different from manufacturing or industrial production. Hotels, cruises ships, restaurants and so on are all about providing customer service and a valuable experience to clients. While service robots can take an enormous variety of forms and shapes to absolve many different functions, it appears obvious how all on these would significantly differ from industrial settings. Robots in hospitality are used and will most likely be used not only to reach cost efficiency and high productivity, but also to enchant the customer or provide him with additional services. However, only few researches and contributions seem to be present on this topic scratching it only on the surface. This translates into a significant practical problem: **There's a lack of clarity regarding what is driving adoption of service automation and robotics in hospitality industry.** Furthermore, **nothing, or only a few is known about which are the technological, organizational or environmental elements influencing adoption of service robots in hospitality**.

1.1.2 Scientific problem

A review of literature on business models and an informed choice of an adequate business model ontology for our research will be discussed in chapter 3. However, we recognize from the beginning the inadequacy of the use of common ontologies alone in our case as part of the scientific research problem. **Business model ontologies, such as Business Model Canvas (BMC) are usually used and constructed putting a strong focus on the customers and on the firms value creation, delivery and capture mechanisms in isolation from contextual and environmental factors.** We, instead, have also the research goal to properly extrapolate and understand those factors. These often play a crucial role not only in determining adoption or acceptance of new technologies, but are also deeply intertwined with aspects of business models of the firms who are introducing technological innovations in the market. We recognize the scientific gap present in research about

merging business model ontologies with theories of technology adoption in order to obtain a more comprehensive and informed set of business model design guidelines for high-tech new ventures. Our aim is to partially fill this gap. Thus, we will make use of BM ontologies in a way that will allow us to cope with intrinsic BM ontologies limitations by including contextual and environmental factors.

2. Research Design

2.1 Research Objective

All the aforementioned elements in Tactile Robots' technology, in the design, application and beachhead market choices made by the startup contribute to gaining a better understanding of the research problem. To tackle the research problem, the main objective of the research is the following:

- **To make recommendations to Tactile Robots about the design of a viable business model for the company by providing an overview of drivers of adoption for service robotics in hospitality, factors influencing those drivers, and customers opinions regarding Tactile Robots' technology-market fit**

For the purpose of our research, we will define as *Viable*, a BM for Tactile Robots that is capable of translating the technological assets, intellectual properties and resources of the firm into economic value and ultimately profits.

It is possible to decompose this overarching research objective into minor sub-objectives that help clarifying the steps needed to achieve the research goal. The identified sub-objectives are:

- Identify the drivers of adoption for service automation and robotics in hospitality industry, together with the relevant factors that are influencing those drivers
- Understand the concept of Business models and Business modeling in the context of high-tech startups and identify the adequate ontologies
- gather and understand customer opinion regarding Tactile Robots' technology-market fit
- extrapolate meaningful recommendation for business model design from analysis of adoption drivers, factors and customer opinions

2.2 Research Framework

According to verschuren[60], in order to formulate a set of research questions from a clear research objective, a research framework is needed. This can be summarized as a schematic representation of the research objective including the appropriate steps needed to achieve it. This scheme is useful to structure visually a clear research plan.

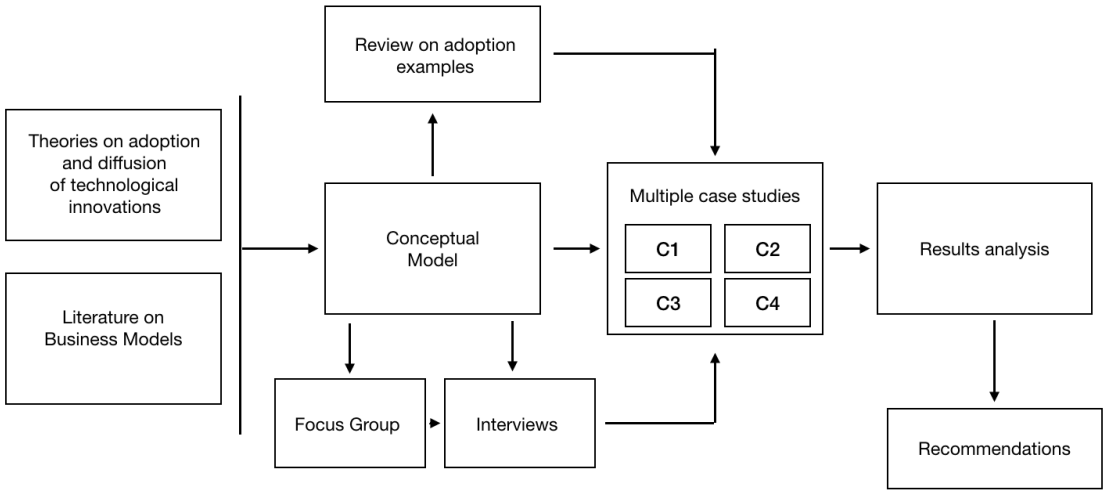


Figure 2.2.1: *research framework*

Referring to fig2.2.1, a first theoretical framework is used to develop a conceptual model. The theoretical framework review touches mainly available literature on business models for technological ventures and theories of adoption and diffusion of technological innovations. The conceptual model is then tested and refined through a review of the current examples of adoption of these technologies in hospitality and empirical research in the form of focus group and unstructured interviews. The conceptual model, together with findings from review and empirical research, will be used as a basis for developing and structuring a set of four case studies. The analysis of these four case studies will be carried out in order to obtain, as a result, a set of informed recommendations for designing a viable business model for Tactile robots.

2.3 Research Questions

The objective described in the previous section, needs clear research questions aimed at achieving it. For the purpose of this research, it results useful to structure the research questions in 3 main elements that builds, in sequence, an actionable set of steering guidelines for conducting the research. It is important to remark how the set of research questions should be both effective, meaning that the answers clearly contribute to achieving th objective, and steering, meaning that they give indication to the actions needed to answer them[61]. Keeping this in mind, the following set of questions could be formulated.
The first research question is mostly theoretical and can be answered by conducing an extensive and detailed literature review on the topic of technology adoption theories and, more specifically, reviewing the current examples of adoption of service robotics technologies in hospitality and available literature on adoption drivers for robotics in this industry. the aforementioned review is complemented with preliminary research.

Research question 1:

- **What is driving and what is influencing adoption of service automation and robotics in the hospitality industry?**

It results useful to decompose the question into sub-questions that help in steering the research towards more narrow and focused branches.

Research subquestions 1:

- Which are the current examples of adoption of robotics technologies in hospitality and what drove their adoption?
- Which are the factors influencing adoption of service robotics in hospitality?
- What it the relationship between adoption drivers and influencing factors?

The answer to this first research questions provides the theoretical insights and instruments that are necessary to achieve the objective of the research. However, the knowledge resulting from this literature review is general and should be applied to our specific case. In order to steer the research towards the final goal the second research question is introduced. This is the core question that will have Tactile Robots' potential customers as units of analysis.

Research question 2:

- **To what extent and under which conditions are customers willing to adopt or to be delivered value from Tactile Robots' product and value proposition?**

Also this time it is useful to decompose it into research subquestions. These sub questions help in giving a clear idea of the practical activities and tasks that need to be performed to answer the broader question.

Research subquestions 2:

- Which are the relevant customer segments?
- Which are the major pains of relevant customer segments that TR's product can alleviate and gains that TR's product can offer?
- What do potential customers think about Tactile Robots' product and value proposition?

Finally, in light of the evidence gathered by answering to the first two research questions, the last one can be introduced which serves directly to reach the final goal of achieving the research objective and solving the research problem.

Research question 3:

- **What can we learn by merging the results of the analysis of adoption drivers, factors influencing those drivers, and customers' opinions in order to make recommendations to TR on how to design a viable business model?**

This last research questions builds on the knowledge resulting from Question 1 (Q1) and Question 2 (Q2). Question 3 aims to merge the theoretical insights coming from the Q1 together with the practical and case-specific knowledge resulting from Q2. Moreover, the answer to Q3 does not simply put together Q1 and Q2, but elaborates on the knowledge gathered with the goal to make the final step of reaching the research objective.

2.4 Research Methods

In this section the methods used to conduct the research are chosen, described and motivated. In doing so, it will result useful to describe the advantages of the methods selected with respect to this particular research as long as the possible disadvantages and obstacles that may be encountered. The first methodology used is Focus Group (FG). Focus group research is a qualitative research method that can be utilized most effectively to respond to sociological research questions. Focus group is a type of in-depth interview which is accomplished in a group of people[40]. Usually it consists of a unstructured or semi-structured collective talk around one topic in a small group of around six to twelve people. One moderator guides the discussion and tries to bring back the generation of concepts towards the focus of the research. FG can be summarized as a guided open discussion about a topic among a small group of people strategically sampled[37]. FG in management research is usually considered as a valid exploratory tool whose results need to be complemented with more in depth research. FG is particularly advisable for investigating action

in new fields or generating ideas or hypotheses based on perceptions of the participants. FG is also a useful method to develop drafts of interviews structures and/or questionnaire for further research[40]. An advantage of FG research is that it allow to gather a decent amount of data in a relatively short period of time, which is exactly our aim for this preliminary research. Moreover, it permits a unique richness and flexibility of data collection. Group interaction and non-verbal communication between members of the target sample are the primary benefits of FG research. Focus Group has high face validity and allows researchers to increase the size of the sample of qualitative studies. It is indeed a great tool in the construction of frameworks that allow for further investigation.

According to Oliveira[40], FG research is not advisable in the following cases:

- when the subject is constraining the participants
- when the researcher does not have control of the critical aspects of the study
- when there are necessary statistical projections
- when other methods can produce results with better quality or more economically

Any of the aforementioned issues is applicable to our case, so there are no restriction of the use of FG research.

FG research, as any qualitative research methodology, requires careful design and preparation. Williams[37] outlines five stages in the process for preparing, conducting and reporting focus groups results. The five stages are: Purpose, conceptualization, logistics, facilitation, analysis and reporting. These five stages are suggested in order to develop an effective and valid FG. For the purpose of our research, we will summarize those into three main steps: planning, conduct of the FG and analysis. In our case, we will use Focus Group as a preliminary initial stage of our research, in order to finalize our conceptual model and guide us in the construction of the case studies. this research methodology perfectly fits with the scope of generating ideas and identifying drivers and factors that will serve as a tool to structure the further part of the research.

Empirical research has note been limited to a single Focus Group. The FG, instead, revealed major areas of interest that was worth diving into. The insights generated by expert panel discussion, in fact, were used to structure a subsequent research step. One participant to the FG, coming from the academia, invited the researcher to investigate deeply the topic with colleagues experts in the field. So, a round of unstructured electronic interviews was organized. Interview as qualitative data collection method is widely used in social, organizational and business research. Interviews can be defined as an intensive individual discussion with the goal to explore interviewee perspectives on a particular idea, program or situation[4]. Interviews can take place face-to-face, on the phone, or through more modern electronic video devices. A primary benefit of interviews as a data collection method is the ability of the researcher to maintain control over the discussion flow and the chance to dive deep into some topics and/or ask for clarifications. Empathy and comfort created during interviews are another advantage of this data collection method. Moreover, Usually, just few interviews are enough to obtain a clear and in depth knowledge. Compared to focus groups, in interviews, there are none of the potential distractions or peer pressure dynamics that can sometimes emerge when multiple interviewees interact among each other. Finally, interviews can be really insightful and allow for the identification of key takeaways really quickly. On the other hand, interviews are extremely time consuming. The time required to contact and arrange a proper time and location with all the potential interviewees could be significant,and it is important to carefully sample the population that the researcher wants to include. For the purpose of our preliminary research, a total of three interviews were carried out with participants sampled among experts from a worldwide renowned academic institution in the field of hospitality business and management. The interviews had a goal similar to the FG: complement research on adoption drivers and influencing factors.

2.5 The case study methodology

Knowledge gathered from both FG and interviews will enrich the conceptual model and provide guidance in structuring further multiple case studies research. The choice of multiple case studies is motivated by the need to generate an in-depth specific knowledge rather than broad knowledge. A case study is all about examining a certain phenomena within its context. Tactile Robot's research problem requires observations and investigations within an authentic environment. This would, for example, contrast with an experiment which isolates a phenomenon from its context[63]. As a disadvantage, The choice of a case study will make results less generalizable. However a case study will be adequate to reach the research objective, since, as we learned from the theory: the viability and suitability of business model can only be determined against particular contexts or business environments rather than be assessed abstractly and generally.
Moreover, the case study requires pre-structuring only to a small extent, allowing for a flexibility that can be enormously precious in the extremely dynamic and rapidly changing context of a high-tech startup facing its go-to market phase. The case study for our research problem has an exploratory nature[62]. The knowledge generated through the case study will serve to obtain a general picture of the research project giving the researcher the chance to always be able to steer towards the final objective.
For our purpose, the case study methodology will entail intensive face-to face interviews with potential customers and triangulation of methods combining the aforementioned individual or group interviews together with content analysis of textual and audio-visual material.
In order to achieve the final research objective of giving recommendation regarding business model design to Tactile Robots, it will be used a cross case analysis. A cross case analysis is a case study methodology that compares results from multiple case studies to find commonalities and/or discrepancies useful to gather general insights from the research. The advantages of the cross case analysis methodology can be summarized as providing a more detailed level of inquiry integrating quantitative and qualitative methods into a single research study. Moreover, the methodologies used can be extremely useful where the boundaries of the phenomena of interest and the context are not crystal clear as in our situation. For our case, the multiple case study methodology allows to incorporate the degree of agility and flexibility needed in a high-tech startup context to the research design itself.

Units of Analysis

The unit of analysis for our case study will comprehend independent hotels or hotel chains that are representative of the relevant customer segments niches that will emerge from preliminary empirical research; focus group and interviews, and from review on service robots adoption. A well define and justified sampling strategy for the unit of analysis will be carried out after the first part of empirical research will be completed. If we look at unit of analysis from our research perspective, they represent the *customer segments* block of the Business Model Canvas. The identification of units of analysis and their justified choice is thus part of the final research goal.
It is important to stress how, in our multiple case-study, the same approach, protocol and data collection methods will be performed in each case or unit of analysis. From a research perspective, this will result in a repetition of the case study without substantial modification of the details in the structure of the case-study itself. This will allow to maintain a focal view and a recurrency in the structure that will make possible to perform a final cross case analysis[62].

Case study Protocol

As mentioned, research design is all about linking data collection processes and methods with the research questions. In order to achieve this goal, a case study protocol need to be set up. According to Yin[62], The protocol, containing a set of general rules and the procedures, is useful to guide the researcher in the data collection process increasing the reliability of the case study. Yin[62]

distinguishes five levels of questions in a case study protocol. Each level refers to the granularity of the question with respect to the whole research:

- **Level 1:** Questions asked to specific interviewees
- **Level 2:** Questions asked on the individual case
- **Level 3:** Questions asked on pattern of findings of multiple cases
- **Level 4:** Questions asked on the entire study
- **Level 5:** Question asked beyond the narrow scope of the study (conclusions or recommendations)

Table ref.2.5.1 shows at which level are positioned the research questions for our specific case study research. Research question 1 does not appear in the table since it will be addressed through a literature review and preliminary research.

Research Question	Level
Q3	5
Q3	4
	3
Q2	2
	1

Table 2.5.1: *Datasets and their sources*

While The higher levels (2,3,4,5) are useful to directly answer the research questions, level 1 accounts for the most operative level. Questions of level 1 are directed to the interviewees and will be posed directly to people working in the organizations selected as units of analysis. In this section we will narrow our focus to levels above 1.

In order to develop and maintain a high level of reliability for the case study, multiple sources of evidences will be used to collect data. Table 2.5.2 summarizes the sources of evidence that will be used to collect data to answer each research question. Overall, sources of evidence include interviews, observations and documentation.

Following table 2.5.2, first of all relevant customer segments need to be identified. Subsequently, people strategically sampled among hotel managers or staff will be intensively interviewed in order to understand their opinion both regarding the technology and the methods and conditions under which they are willing to benefit from Tactile Robots' value proposition. The final elaboration and reflection on the results of the cases, together with the insights coming from literature review will produce the knowledge required to effectively tackle the research objective, namely, to give informed recommendations to TR on the design of a viable business model.

Data Collection

As summarized in Table2.5.1 multiple data collection methods or sources of evidences will be used. Hotel managers and Executives will be interviewed and it will be asked to provide useful documentation if present. Data collection will be also performed by searching for on-line textual and audiovisual documentation regarding the units of analysis selected for the cases.

Interviews

In this section we will narrow down the scope to questions at level 1 of the case study, directed to the interviewees. Interviews are one of the most used knowledge-producing practice across human and social sciences which has "the purpose of obtaining descriptions of the life world of the interviewee in order to interpret the meaning of a described phenomena".[7] For the purpose of this research, there will be no completely structured interviews with a clear pre-defined set of questions. The interview guidelines will have the only goal to ensure that every relevant topic

RQ	Research Question	Research Subquestion	Sources of evidence
Q2	To what extent and under which conditions are customers willing to adopt or to be delivered value from TactileRobot's product and value proposition?	Which are the relevant customer segments?	• interviews • Documentation
		Which are the major pains and gains that TR2s product can alleviate or offer?	• interviews • Observations
		What do potential customers think about TR's value proposition?	• Interviews
Q3	What can we learn by merging the results of the analysis of adoption drivers, factors influencing those drivers, and customers' opinions in order to make recommendations to TR on how to design a viable business model?		• Documentation

Table 2.5.2: *Research questions and their sources of evidence*

have been discussed. Interview guidelines will be constructed after the first part empirical research is completed. This will ensure their ex-post validity. The aim is to set up a natural conversation between the interviewer and the interviewee. This approach is intended to avoid as much as possible any kind of bias towards Tactile Robots' solution and the condition under which potential customers are willing to be delivered value, and to understand facts and behaviours of the interviewee. In the annexes the topics that will be the subject of the interviews for the groups of interviewee are presented. The guidelines on the topics are directed more to the interviewer rather than being direct questions to be asked, and they are not intended to be exhaustive and inflexible. Interviews could be extended or steered towards a particular direction if the interviewer finds that digging down into a particular aspect might be a source of valuable information for the purpose of the research. Generally speaking, while topics to be covered will vary across groups, the interview will always be concluded asking whether an additional interview can be done with a subject that is judged being relevant by the interviewee.

Data analysis

The case studies data analysis will be done qualitatively by building an explanation about the evidence collected through the identification of a set of causal links, coding and data reduction. Explanation will be the result of series of iterations that go from comparing findings and details of the case in the first unit of analysis to other units. Analysis should show that It relied on all the relevant evidence and most significant issues of the study are addressed. For our case, factor analysis will be also performed for each individual case and results will be analyzed and merged into a cross case analysis.

2.6 Thesis Outline

In this section, we describe the structure of the report as well as the general structure of the research. The first three chapters (1,2,3) constitutes the background of the research. In Chapter 1 an introduction to the problem and its context is provided. Chapter 2 clarifies the research objectives, the research questions and the framework giving an overview of the whole architecture of the research which is the following. Literature review is done in chapter three around the 2 main topics of business models and theories of adoption of technological innovations which constitute the theoretical framework for the whole research. This is used to build a the general conceptual model of our research. Chapter 4 is dedicated to solve the practical research problem and starts with a review on adoption of service robots in hospitality industry. Drivers of adoption of robotics emerge from this review. Chapter 5 describes the first empirical research carried out in order to extrapolate further adoption drivers and influencing factors. Results from review, focus group and interviews are summarized and discussed in Section 5.4. The subsequent portion of the report elaborates on the findings from case studies research and has the aim of reaching the research objective solving also the scientific research problem. In Chapter 6 case studies analysis is structured and carried out. Finally, in chapter 7, we discuss the results of the cases and extrapolate general conclusions and recommendations. Part four collects appendix elements and the references list.

3. Theoretical framework

Relevant literature will be reviewed around the concepts of business models and theories of technology adoption, which, together, constitute the theoretical framework at the basis of our conceptual model. The review starts from stakeholder theory. While it is not directly involved in the conceptual model, stakeholder theory is the theory of the firm at the basis of our research: we look at the firm under the stakeholders theory point of view.

3.1 Stakeholders theory

It is useful to introduce the basic concepts and foundations of stakeholder theory since the whole research is based on the view of the firm and its objectives provided by this theory. The literature review around this topic has not the goal of summarizing the state of the art of the theory, which has been extensively done by its main authors and contributors in the work "Stakeholder theory: the state of the art"[44]. Our goal is, instead, to show how this theory plays a key role in understanding the scope of this research and its foundations. Moreover, we want to elaborate on how stakeholder theory and the concept of managing for stakeholder come into play in the context of high-tech new venture creation process, how they are linked to our research and why they are relevant for our objectives. As we will notice, in fact, there has been only a little and scarce contribution to the theory to accommodate the context of new nascent ventures. Keeping this in mind, we will follow the line of reasoning of Pollack and Barr[47], who make the case that stakeholders relationships and trust establishment must be examined differently for nascent startups where any sort of collaboration or relationship is not already in place.

The theory: foundations

"Stakeholder theory" or "stakeholder thinking" has emerged in the last 35 years as a new narrative to understand and facilitate the framing of the complexities of today's business challenges[44]. The stakeholder approach, in fact, can be increasingly useful in a world that is becoming ever more interconnected, dynamic and turbulent with blurred boundaries between firms and public and private lives.[18]
The roots of the theory and the first introduction concept and the definition of the term "stakeholder"

are dated back to the 60s with the pioneering work of SRI (Stanford Research Institute)[18], which looked at the support of all stakeholders as central to the success of the firm defining them as

"those groups without whose support the organization would cease to exist".[15]

The idea arose from the contemporary organizational theories on the nature of the firm which showed the difficulty to describe an organization without full recognition of the relationships on which it depends. Stakeholders theory core concepts can be summarized saying that economic value is created by people who voluntarily come together and cooperate to improve everyone's circumstances. While shareholders are fundamental and profits are critical to the success of the firm's goals, the ultimate objective of the firm is to develop relationships and create communities where everyone strives to give their best to deliver the value promised.
Although stakeholder theory, along its development, has often been framed in terms of "stakeholders vs. shareholders" debate, focusing solely on that and on the nature of stakeholders theory as a "theory of the firm" obscures the most useful and powerful traits of it. As Freeman points out[19], the central insight of the whole theory is the jointness of stakeholders interests that opens the path towards the idea of "managing for stakeholders": the best deal for all is if managers try to create as much value for all stakeholders as possible.
Freeman, defining "stakeholders" as

"any group or individual who is affected by or can affect the achievement of an organization's objectives"[18]

points out how the whole idea of stakeholder theory is not just to recognize their existence, map their interests and power and act in order to maximize the firm's objectives. Freeman, instead, recognizes how the firm's objectives are bounded to stakeholders objectives and how an organization should act in order to actively affect and influence all these intertwined goals and relations introducing in this way the concept of "managing for stakeholders"[48]. Stakeholder management can be seen as a never ending task of integrating and balancing multiple relationships and multiple objectives. Customers, suppliers, financiers, communities and managers are the key actors of today's business organization and business itself can be understood as the set of relationships and interactions among these groups which have a stake on the business in order to create value[19].
In this research, We recognize how the entrepreneur's work is to manage and shape these relationships in order to find the "sweet spot" that signifies the joint interest of all key stakeholders. Taking away the support of any of the stakeholders will result simply in a not viable business and no viable business model could be identified. We will take this into major consideration while performing our research, we do not want to limit our investigations to customers and groups directly involved in the firm's value chain. We do this in order to gain a much wider and comprehensive perspective on the research problem and its solution.

3.2 Business Model

3.2.1 Role and Relevance of Business Models

First of all it is useful and needed to understand the concept of business model (BM), what it is and which are its building blocks. The existing literature and research around Business model and business model design is extensive and shares a common consensus on the fact that a good business model is essential to every successful organization, both for established players and for new ventures. In this and in the next sections of literature review the aforementioned research will be analyzed in order to answer to the first research question.
In a first instance, in order to contextualize and understand the relevance and the role of business model design for the case of Tactile Robots, it will be presented how literature stresses the

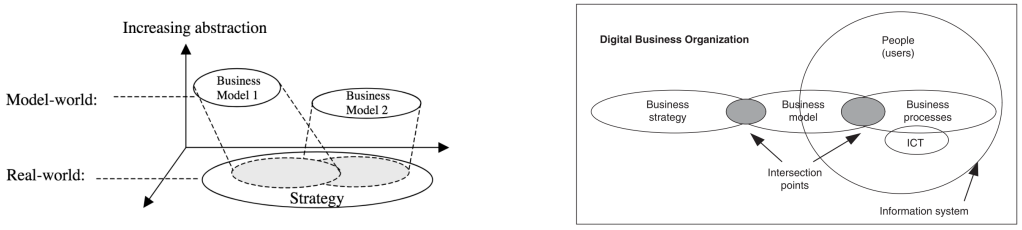
importance of BM for technological innovations and why the relation between business model and technology is of paramount importance.
The value brought to society by applied research and technological innovations remains latent until they are in someway introduced into the market and commercialized. This implies that organizations take technology to market through a viable business model aimed at delivering and capturing value from a technological innovation. Figuring out how to capture value from innovation, which entails designing a viable business model, is thus a crucial aspect for the commercial success of an innovative product or service. Teece[56] heavily underlines how every new product development process should be coupled with the design of a business model that defines the 'go to market' strategy and the logic behind the value capturing strategy.

> *"To profit from innovation, business pioneers need to excel not only at product innovation but also at business model design, understanding business design options as well as customer needs and technological trajectories"*[56]

Chesbrough and Rosembloom [10] argue how firms need to understand the cognitive role of business models in providing a framework that mediates between technological development and economic value creation. Without a well-structured business model connecting the technical potential with the realization of economic value, innovators inevitably fail to either deliver or to capture value from their innovations. Moreover, also according to Fuller et al.[3] business model has a moderating effect between technology development and performance outcomes, determining the bridge between technology and monetization. The authors also underline how the connection between business model choice and technology is double-sided, complex and very powerful.
The bottom line of this reasoning is that technological innovation in itself does not lead to commercial success. In order to turn technical success into commercial success, a viable business model must be designed, implemented, and coupled with a careful strategic analysis. This, in short, reflects the relevance of business model design and its relation with technology for the case of Tactile Robots.

3.2.2 The Business Model concept

Many definitions of the concept of Business Model exist in literature and the research around business models have been very productive in the last decade due to the booming of internet-based businesses. A heated debate has also been on the precise definition of BM and the distinction of this concept from the one of strategy. However, It is not the aim of this research to organize the literature around this topic nor to fill research gaps in the distinction or delineation of the two aforementioned concepts. So, for the purpose of our research we will assume that Business Model is not the same thing as strategy following ideas of Magretta[32], Seddon et al.[52] and Al-Debei[13]. From an ontological perspective, while strategy is a dynamic concept encopassing activities and processes, the business model is a static construct that abstracts organizational elements, describing how different elements of the business fit together without placing the firm's logic in a highly situated context. From a functional and operational point of view, instead, BM could be seen as a conceptual tool of alignment that, as an intermediate layer, translates business strategy into business processes. Figure 3.2.1 gives a visual representation of the relation between BM and strategy that we will keep in mind for clarification.
This section of literature review has the final goal of presenting some definition and aspects of business models and gather knowledge necessary to advise Tactile Robots on its business model design. Keeping this in mind, It will be presented a brief overview on the most relevant definitions of BM, the majority of those could be seen as different ways or angles to look at the same underlying concept.



(a) *logical perspective[52]*

(b) *functional perspective[13]*

Figure 3.2.1: *The relationship between Business Models and Strategy*

Teece [56] defines the business model as a description of the architecture and design of value creation, delivery and capture of a firm. According to the author, A BM defines how an enterprise creates and delivers value to customers, and then converts payments received to profits, articulating the architecture of revenues, costs and profits. In short, A business model expresses the underlying business logic of a firm's go to market strategy.
Magretta [32], on the other hand, sees BMs as stories, and business modeling as storytelling.

> *"Business Models are, at heart, stories. Stories that explain how enterprises work. A good business model answers Peter Drucker's age-old questions: Who is the customer? And what does the customer value? It also answers the fundamental questions every manager must ask: How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost"*[32]

In addition, the work of Chesbrough and Rosembloom[10] results extremely useful for the purpose of our research since they provide an operational definition of business model. Defining the BM in this way helps in identifying both the elements of the business model and the practical activities that are needed in the business model design. Moreover, Chesbrough and Rosembloom articulates the definition and elaborate on business model with respect to the highly technological innovative activity of Xerox, thus representing a useful parallelism to our case. We report the **functions** of a business model as stated by the authors due to their relevance for this research. The functions of a Business model are to:

- **articulate the value proposition**, i.e. the value created for users by the offering based on the technology
- **identify a market segment**, i.e. the users to whom the technology is useful and for what purpose, and specify the revenue generation mechanism(s) for the firm
- **define the structure of the value network** within the firm required to create and distribute the offering, and determine the complementary assets needed to support the firm's position in this chain
- **estimate the cost structure and profit potential** of producing the offering, given the value proposition and value chain structure chosen

To conclude, Al-Debei[13] tries to build a comprehensive and unified conceptual framework for the BM concept, with the main aim of providing a cohesive understanding of BM. The thorough content analysis carried out by the author results in the build up of a concrete BM definition. Al-Debei defines BM as:

> *"an abstract representation of an organization, be it conceptual, textual, and/or graphical, of all core interrelated architectural, co-operational, and financial arrangements designed and developed by an organization presently and in the future, as well*

all core products and/or services the organization offers, or will offer, based on these arrangements that are needed to achieve its strategic goals and objectives."[13]

All in all, If we try to draw a bottom line on literature around definition of business models, following the work of Massa and Tucci[34] there are comprehensively three distinct interpretations of what a business model is: an attribute of a firm, a cognitive or linguistic schema, and a formal conceptual representation describing the activities of a firm. Regardless of which of the 3 interpretation regarding the essence of a BM, it is possible to conclude that a proper way to summarize business models is viewing them as critical constructs that underline how value is crated and captured by an organization.[20]

3.2.3 Business Model Design

Generally speaking, two fundamental ideas guide business model design. The first is that the viability and suitability of business model can only be determined against particular contexts or business environments rather than be assessed abstractly and generally. This stresses the need to focus not only on the internal variables of an organization, but also on the external environmental factors. So, although we defined the Business Model as an abstract construct, BM design, instead, entails diving deep into the concrete operating environment of the firm, taking into great consideration external variables such as national culture, market opportunities, laws and regulations, customer-base size and nature, competition level, and technological advances. The second idea that guides business model design is that Business modeling can be seen as the managerial alternative to the scientific method: it starts from one or more hypotheses about customers and market that then need to be validated, tested in action and revised.[64] The choice of a particular business model ontology, defined as way of of visualizing and structuring the business model is particularly important. Multiple ontologies are available in the literature, such as the STOF model, fluidminds, the business model canvas, the value model and many more. For the purpose of this research the ontology used will be the Business Model Canvas (BMC) designed by Osterwalder[42]. BMC is a simple, straightforward and practice oriented tool that sees business models as being composed by nine building blocks, namely: customer segments, value propositions, channels, customer relationships, revenue models, cost structure, key partners, key resources and core competences. What make Business model canvas the most useful ontology for the purpose of our research are the criticisms that have been moved against it. BMC does not provide a view on external forces. These external forces, however, will in fact be takes into account as they are called "influencing factors" in our research and will be one of our research objects. Furthermore, we will focus only on three out of the nine building blocks as can be seen in figure 3.2.2 Our final research goal is to give recommendations on:

- Customer segments
- Value Propositions
- Revenue model

The three building blocks are defined, according to [42], as follows. **Customer segments** defines the different groups of people or organizations an enterprise aims to reach or serve. Customers are at the hearth of any business model. The more refined and detailed the customer segments identification is, the better is for the success of the whole business model. In this research we aim to provide an in depth analysis and identification of target niches within hospitality industry. The **Value Propositions** building block describes the bundle of products and services that create value for a specific Customer Segment. It can be seen as the aggregation, or the set of benefits and values that a company offers to customers. Value propositions are not limited and usually not explained by product and services but by their ultimate value conveyed or problem solved. Finally, The **Revenue Streams** Building Block represents the modality under which cash is generated by a company by

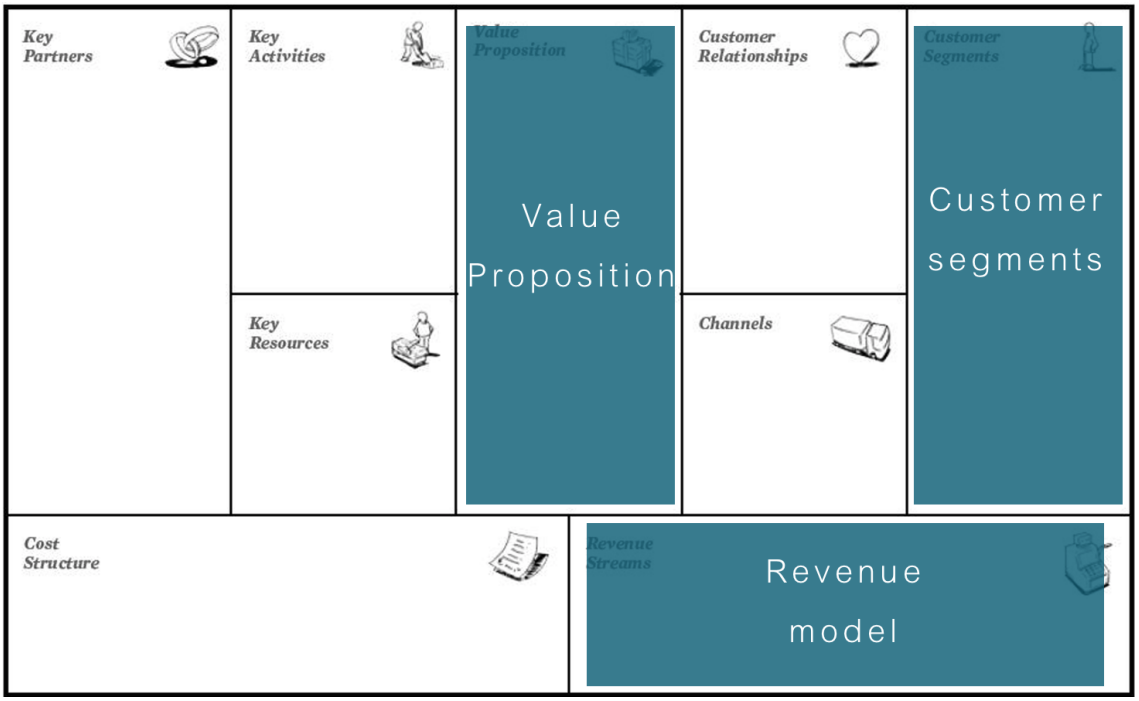


Figure 3.2.2: *Business Model Canvas and the three blocks under the research scope*

each customer segment. It refers specifically to the conditions under which the value is captured by the firm from the customer and specifies the practical specifications of the transactions.

3.3 Adoption of technological innovations

During last decades, with the booming of technological innovations, there have been a number of researches addressing adoption and diffusion of new technologies both at a consumer and at a firm level. A number of theories has been also developed to explain users and customers acceptance of new technologies. Probably the most known and cited theory in this field is the model on "diffusion of innovation" developed by Rogers (1995)[50].

Lai et al[31] and Olivieira [41], provide a comprehensive and satisfactory review on theories of adoption, diffusion and acceptance of new technologies. Beyond Rogers (DIT) Diffusion of Innovations theory, reviews report many theories focused to acceptance of new technologies such as Technology Acceptance Model (TAM) developed by Davis, Theory of Reasonable Action (TRA), or Theory of Planned Behaviour (TPB). However, those theories are not considered relevant for the purpose of this research. Our first focus is to understand what theories are useful to structure our conceptual model. We aim to reach understanding of what is driving adoption of service robotics in hospitality and what is influencing adoption. Furthermore, it is not intended to provide here a complete review of available theories on technology adoption or diffusion, which is something that has been extensively done by other researchers. As a first step, we narrow down the scope towards theories of adoption at the firm level: Rogers' DOI theory and Technology, Organization and Environment (TOE) framework developed by Tornatzky and Fleischer [57].

DOI can be defined as a theory that describes how and why a technology spreads across cultures, at an individual and firm level[41]. The theory describes and elaborates on the process of adoption and diffusion of an innovation through different stages which include understanding, persuasion, decision, implementation and confirmation. The analysis of these stages resulted in what is known as Roger's S-shaped adoption curve. The curve, depicted in figure 3.3.1 distinguishes five different

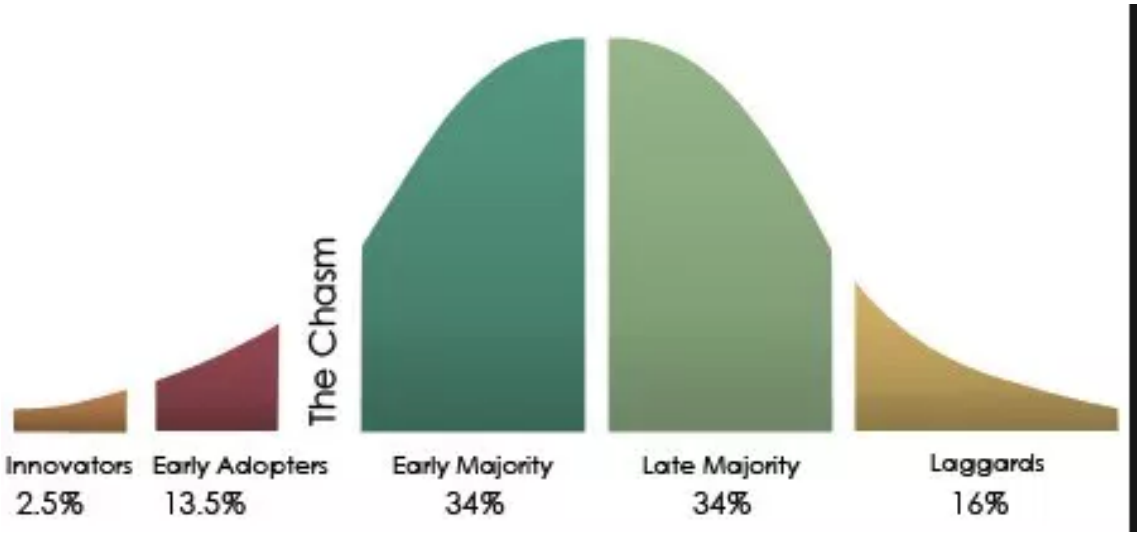


Figure 3.3.1: *Rogers' adoption curve*

groups of adopters based on their adoption propensity: innovators, early adopters, early majority, late majority and laggards. It is generally observed that the adoption of an innovation is usually normally distributed over time among the aforementioned categories of population. According to the theory, a technology is first adopted by a small percentage of innovators and early adopters, and has to cross a delicate region called "the chasm" in order to reach major diffusion and acceptance among early majority. Many companies and technologies fail in crossing the chasm. At the level of organizations, the process is much more complex and variable. According to DOI, Innovativeness at a firm level is related to a number of independent variables such as individual leader characteristics, internal organizational structural characteristics, and external characteristics of the organization. DOI has been applied and adapted in various ways with respect to different technologies adoption. It is useful to report a table from the review of Olivieira [41] which gives an idea of the adaptations made and the cases in which DOI theory has been utilized in previous researches.

Table 3.3.1: *Some studies based on DOI theory (Rogers) [41]*

(IT) Technology Adoption	**Author(S)**
Material requirements planning (MRP)	(Cooper and Zmud 1990)
IS adoption (uses at least one major software application: accounting; inventory control; sales; purchasing; personnel and payroll; CAD/CAM; EDI; MRP), and extent of IS (number of personal computers and the number of software applications) Intranet	(Thong 1999)
Intranet	(Eder and Igbaria 2001)
Web site	(Beatty et al. 2001)
Enterprise resource planning (ERP)	(Bradford and Florin 2003)
E-procurement	(Li 2008)
E-business	(Zhu et al. 2006a)
E-business	(Hsu et al. 2006)

The Technology, Organization and Environment (TOE) framework was developed in 1990 by Tornatzky and Fleischer [57]. At the firm's level, three aspects are identified as being influential

to the process of adoption and implementation of a new technological innovation: technological context, organizational context, and environmental context.

- **Technological context** describes technologies relevant to the firm internally and externally, including internal practices, and external technologies.
- **Organizational context** refers to descriptive measures about the organization such as scope, size, and managerial structure [41]
- **Environmental context** refers to the landscape in which an organization conducts its business including competition, market and industry and government

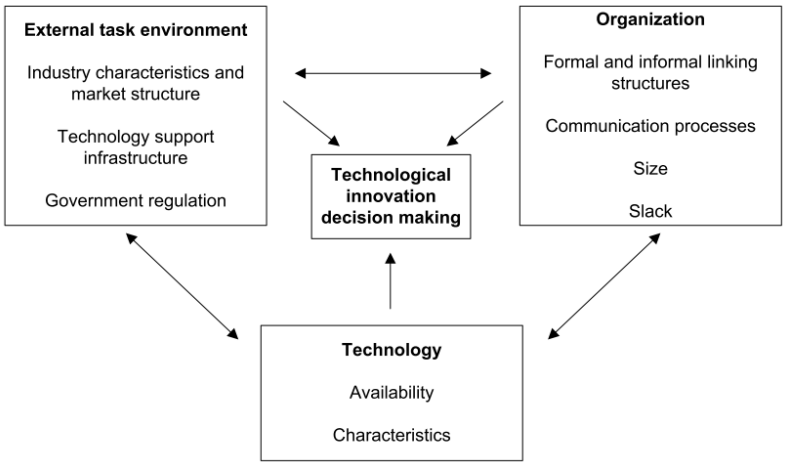


Figure 3.3.2: *Technology, organization, and environment framework (Tornatzky and Fleischer 1990)*

Figure 3.3.2 summarizes the structure of TOE framework. TOE framework has solid theoretical basis and it is consistent with DOI theory but it includes also the the important environmental context.
TOE framework provides a suitable reference framework and theory for the purpose of our research. Adoption of service robotics in hospitality is certainly at its initial phase and our aim is to gain a comprehensive overview of the element of the organization, technology and environment that play a key role in determining adoption. TOE framework will be adapted to the practical scope of our research and translated into a meaningful conceptual model that will constitute the backbone of the structuring the research.

3.4 Conceptual Model

In this section, the conceptual model used for our research is presented and the main concepts that emerge are explicated. On one hand, this is of major importance for our practice-oriented research. Generally, in practice oriented research, and so in our case, the relevant literature definition of concepts and theories need further elaboration as concepts are usually too broad, complex or abstract[61]. On the other hand, a conceptual model is not always relevant in a research project. In exploratory, practice oriented research such as ours, conceptual model play a minor role in comparison to theory oriented or explanation research. However, we found relevant to present the main concepts, give clear definitions and describe the interrelations among them.
First, taking the TOE framework as a model, the three domains of technology, organization and environments can be seen as set of factors influencing adoption of a new technology. In the case of service robotics, technology could take many different forms and absolve many different functions bringing substantially different values to the firm. A lack of clarity is emerging with respect to which are these values. This translated in the first research question about what is that is driving

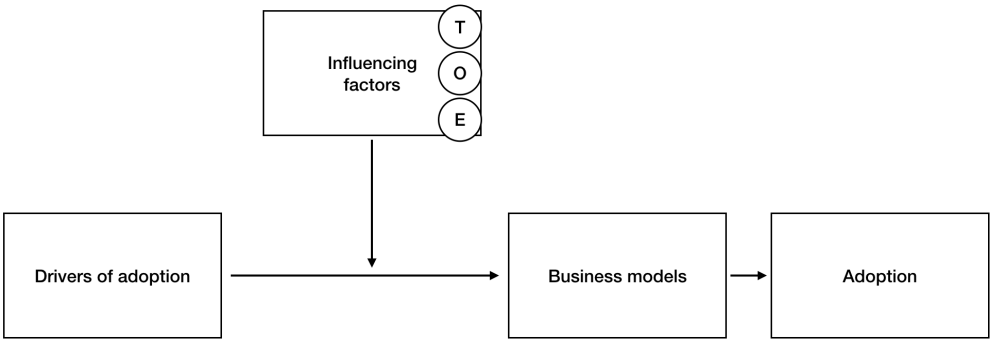


Figure 3.4.1: *Conceptual model*

and can drive the adoption of such technologies in hospitality. We define "drivers of adoption" as the set of ultimate goals that a firm intends to achieve when adopting service robots. Or, framed in the other way around, the set of promised values that service robotics products intend to bring to customers, in this case, hospitality firms. Defined in this way, drivers of adoption take a central role in our research, since they represent the basis for framing value propositions and fill one of the BMC building blocks. Regarding Organization and environment, these could be seen, as mentioned, as two sets of factors that are influencing adoption. For the purpose of our research we will define "influencing factors" as all the elements, belonging to the organizational or environmental domain, which have an influence on the final adoption decision of service robotics in hospitality. We see influencing factors as having a moderating effect on the relationship between drivers of adoption and adoption. This relation is then mediated by the characteristics of business models of service robotics firms. Different aspects of business models can have an impact on the influencing factors in place determining ultimately adoption. The concepts and relationships between them are summarized in figure 7.2.1, which represents our conceptual model.

4. Adoption of service robots in hospitality

In this chapter, a review of service robots in hospitality industry is provided. A thorough search on most relevant on-line academic search engines shows a significant research gap in the field on robotics and service automation for hotels, restaurants, travel and tourism under many points of view. Major areas and topics of research has not even been touched in the field, other have been scratched only on the surface. Among others, the customer acceptance of robots in tourism and operations, the impact of robotics on hospitality financial operations, education, workplace. A consistent research gap has been identified which is relevant for the purpose of this research: the identification of drivers for adoption of robotics and service automation in the hospitality industry. We provide a review on the available research about service robotics in hospitality as a starting point of our further empirical research. The review is structured as follows. First, clear definitions are provided to delineate what is intended for "robotics", "service robots" and "hospitality industry" for the purpose of this research. Second, a description of the methods and sources used is provided. Third, we reviewed the most relevant papers and research that address robotics and service automation in hospitality to focus on the few relevant researches that briefly touch the topic of drivers of adoption for hospitality service robots. A first enumeration and description of adoption drivers is provided. In the last part, we gather all the examples of adoption of service automation and robotics in hotels and restaurants, which are the two focal areas interesting for the practical scope of this research. We provide a comprehensive and complete overview of the state of the use cases of robotics solutions already adopted and working today in hotels and restaurants. To conclude, we integrate the drivers of adoption identified initially by existing research with new ones that emerge from the review of current adoption examples.

4.1 Definitions

It is indeed useful and needed to briefly provide clear, unambiguous definitions of the terms "robot", "service robot" and "hospitality industry" that are used and are relevant for the purpose of this research. In this sections we clarify these definitions.

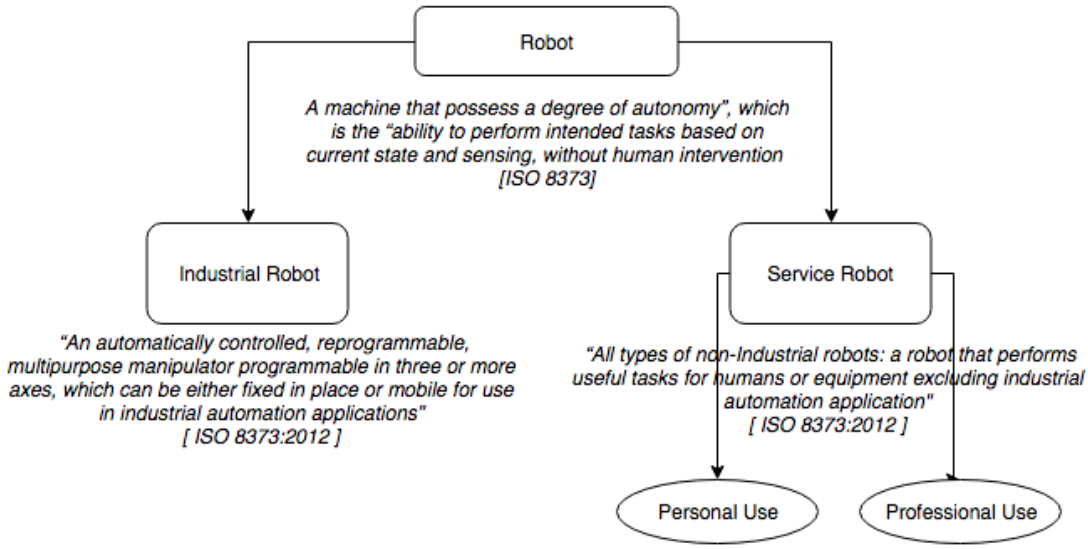


Figure 4.1.1: *Robotics categorization according to standard ISO8373*

4.1.1 Service robotics

In recent years, the significant progresses made in enabling technologies, together with the price decrease of high-level sensors and actuators, led to an impressive progress in robotics and service automation. Robots have entered their way not only in the automation of production sites and manufacturing facilities, but also in warehouses, military and rescue operations, education, medicine, entertainment and even as companions and assistants for the elderly. All these use cases for robotics aside from the manufacturing and production sites fall under the name of service robotics. According to the international Organization for Standardization, all robots may be grouped into two major categories: **industrial robots** and **service robots**. ISO 8373, or the "ISO Robotics standard" categorizes and defines robots. The ISO standards are defined by the International Federation of Robotics (IFR). Generally speaking, a machine, to be defined as a "robot", requires a "a degree of autonomy", which is the "ability to perform intended tasks based on current state and sensing, without human intervention". The definition of Industrial Robotics is found in standard ISO 8373:2012, that is: "An automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications". Typical applications of industrial robots include welding, painting, assembly, pick and place for printed circuit boards, packaging and labeling, palletizing, product inspection, and testing; all accomplished with high endurance, speed, and precision. For Service Robotics, the definition proposed by the ISO TC 184/SC2 Committee is "All types of non-Industrial robots". The IFR also gives the following definition: "Is a robot that performs useful tasks for humans or equipment excluding industrial automation application"[1]. For service robots the "degree of autonomy" ranges from partial autonomy - including human robot interaction - to full autonomy - without active human robot intervention. The IFR statistics for service robots therefore include systems based on some degree of human robot interaction or even full tele-operation as well as fully autonomous systems[23]. The definition makes clear how the variety of purposes, applications, use cases, as well as shape, functionality and embodiments of service robots is significant. Service robots are categorized according to personal or professional use.

For the purpose of this research, we will narrow down the scope on robots and service automation solutions introduced and adopted in the hospitality industry.

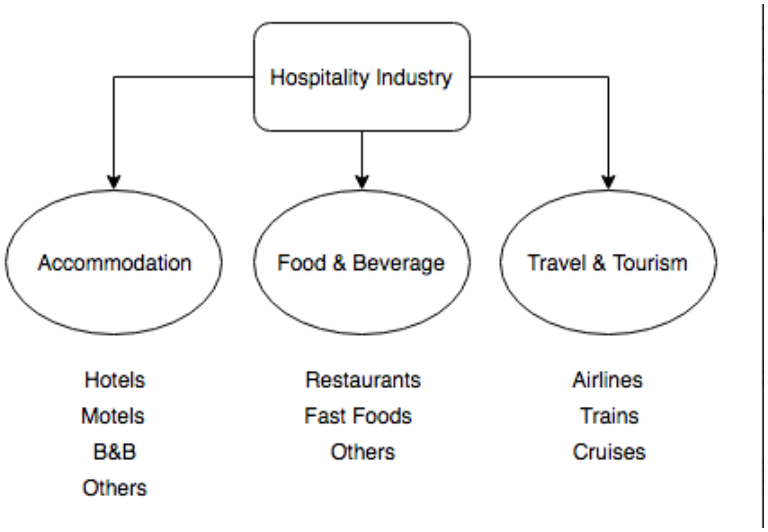


Figure 4.1.2: *Hospitality Industry sectors and segments*

4.1.2 Hospitality Industry

Hospitality industry is a broad category which comprises many customer service oriented businesses. Customer service is in fact the primary foundation of hospitality industry as a whole. Globally, hospitality is the fastest growing industry adding one new job every 2.5 seconds on average[14]. The industry growth rate is about 4.3%, in comparison to the overall worldwide 3.0% of the total global economy, contributing for US$7 trillion annually to total world domestic gross product. About 9.1% of all jobs worldwide are employed in the hospitality industry counting about 266 million people. This industry is forecasted to create additional 75 millions jobs in the next decade. Hospitality could be segmented into three main different areas of businesses, namely: Accommodation, food & beverages (F&B) and travel & tourism. The first comprises hotels, motels, beds & breakfast and other establishments offering accommodation. F&B, instead, comprises restaurants, fast-food chains and other establishments offering F&B services and products. Finally, under the segment of travel & tourism fall airlines, trains and cruise ships. In order to be aligned with the practical goal of the reserach, we narrow down the focus on the first two sectors of hospitality industry, namely: Accommodation and F&B. We also include cruise ships in the sector of accommodation as they are judged relevant and host interesting use cases of robotic solutions.

4.2 Methods

This systematic literature review was conducted using mainly Google scholar as a search engine. Emerald Insight, ResearchGate and Elsevier has been the most relevant libraries utilized. Relevant sources have been the Journal of hospitality management and database of Ecole Hotelier de Lausanne. The studies were included with no restrictions based on the year of publication and type of study. Keywords used to collect literature were: "Service robotics", "hotel robot", "Hospitality robot", "automation hospitality", "robotics hospitality". After a first screening, a total of 30 articles were retrieved and examined as full text. The topic of this review is novel and, as mentioned before, academic research on service robots for hospitality is still at an embryonic stage, so main papers scratch only the surface of research problems.
To review the state of the art and current adoption examples of robotics and service automation in hospitality, Google has been used extensively. The most relevant sources identified were tech blogs or websites such as TechCrunch, CrunchBase or Wired. Newspapers such as BBC, The Guardian and so on also have been used. Finally food and hospitality blogs such as The Spoon provided

interesting information and were included in the study.

4.3 Literature review

This sections provides a review on the state of the art of academic business and management research on robotics and service automation in hospitality industry.
On one hand, hospitality industry and hotel in particular have never been characterized as technology early adopters. For this reason, since service robots are a relatively novel technology, the research gap identified is partially justified. On the other hand, recently, a higher interested has been created towards automation of low skills jobs in hospitality due to increase of minimum wage and restricted changes to employee scheduling. Thus, research around this topic is becoming increasingly sought after and relevant.
The wide majority of relevant papers reviewed mostly just underline the need of research in the field without providing significant solutions or addressing extensively particular research problems. Murphy et. Al, for example, underline how the tourism and hospitality literature or the service literature in general, seem to have ignored service delivered by robotic devices. They encourage research addressing the revolutionary challenge that managers will face in integrating robots into an already complex service system involving employees, customers, suppliers and physical as well as IT infrastructure [36]. The same authors developed also an extensive research agenda aimed at covering the many research gaps involving the topic of robots in hospitality and tourism [36]. Among other gaps, the authors particularly invite scholars to address the desirability of robots in hospitality from the consumer side. Only one study has been found, by Park et al. who explore the evaluation of hotel service robots from the consumer point of view. In the study two service robotics solutions where used and evaluated: Softbank's NAO, a humanoid robots used for check-ins, and Savioke Relay indoor delivery robot[44]. Primawati explores the role of artificially intelligence robot in the hotel industry, which can be seen as an ultimate personalization service fro guests[55]. Sartor et. al investigates a possible use of service robots for collecting customer feedbacks in hotels by conducing semi-structured interviews with administrative staff of hotels which had adopted a Savioke Relay robot for automated room service delivery[27].
Kuo et. al underline the need of further research investigating the ROI of service robots solutions together with quantitative study about robots adoption[30] . Ivanov, Webster and Berenzina addressed, only superficially, the question of how technology will impact the hotel industry providing a brief review of the current available examples of robotics and service automation in the hospitality industry[25]. Law et. al [11] stress how research is needed to identify which technology products and services are being utilized in terms of automation and robotics, and how technology adoption will affect labor needs and skill sets in the hotel industry.
Other authors briefly explain and elaborate about the difficulties in the introduction of robots in hotels underlying how the hotel industry in fragmented in ownership, comprising many independent owners, management contracts and franchise agreements and how this complicates the process of technology diffusion [11].
Initial research is being done in the field of robot-friendly design of facilities and building requirements to successfully integrate robots [26].
Unlike robots in industrial settings, whose performance metrics solely depend on efficiency, the success of service robots is also deeply linked and dependent on users and customer satisfaction[43].
The work of Ivanov, Webster and Berezina [25] explores the current state and the potential adoption of service automation and robotics in hospitality industry, segmenting it into hotels, restaurants, travel, events, theme and amusement parks, airports, car rental companies, travel agencies and tourist information centres, museums and art galleries. A stringent limitation of this research is that the wide focus on many segments of hospitality and leisure industries resulted in an incomplete and

superficial review of examples of adopted solution and use cases in hotels and restaurants, which represent the ultimate focus of our research.

Alexis, [2] recognizes how robots are making their appearance in many different levels of the hospitality and holiday distribution chain. The research is particularly interesting for our purpose since it is the only one that provides a brief and superficial identification and classification of the main driver of the adoption of robotics and service automation in the hospitality industry. Accessibility, productivity and service augmentation are the three adoption drivers identified. Our aim is to dig deeper into examples of current adoption of service automation and robotics technologies in hospitality, in order to identify and understand the different adoption drivers that are driving hoteliers purchasing decisions.

4.3.1 Adoption Drivers

The first review of all main existing papers which cover the topics of service automation and robotics in hospitality led to the definition of three main drivers for adoption of these technologies. Despite the significant research gap in the field, one paper by Alexis[2] scratches on the surface this topic. Three main adoption drivers can be identified and distinguished and are summarized in table 4.3.1

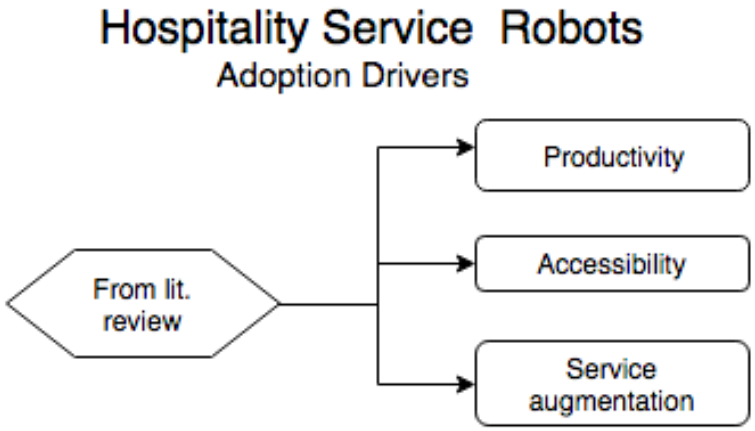


Figure 4.3.1: *Adoption drivers emerging from literature review*

Productivity refers to the use of SR with the aim to increase efficiency cutting costs. This is the most straightforward driver of adoption and it represent the main purpose that drove the diffusion of industrial robots over the last decade. Accessibility refers to the purpose of making hospitality facilities more accessible for customers. One main example is the initial diffusion of telepresence robots which basically improve the video conference experience allowing people connected to remotely operate a mobile robot to navigate around and explore facilities. Finally, service augmentation as a driver of adoption refers to the ability of provide an additional service, or increased value to the customers' experience. The augmentation of the service could come both from an entertainment factor, which involve seeing robots as a fun gimmick, or from a more concrete perspective such as for example luggage carrying robot. Both these elements of service augmentation as an adoption driver could coexist in a unique robotics solution.

In the next section an overview of examples of service automation and robotics solutions already being adopted in hospitality is provided, aimed at identifying other drivers for adoption, if any.

4.4 Service robotics: current adoption examples

Since the late 90s, when the internet started its journey towards becoming a pervasive and fundamental element of most businesses, hospitality has been one of the consumer facing industries most heavily affected by IT and web related capabilities. The initial impact of the web on hospitality had a profound disintermediation effect. Brick-and-mortar tourism intermediaries such as travel agencies and tour operators left the scene in favor of electronic markets for holidays and hospitality components with the corresponding drastic reduction of transaction costs[2]. Booking.com, Expedia, AirBnB and so on, are the major examples of how the hospitality business had, over the last decades, shifted heavily towards an on-line dimension. Nowadays, as we approach the third decade of the 21st century, a new wave of technological innovation seem to be about to flood the hospitality sector. The development of Artificial Intelligence and robotics is now at a turning point, and in the very last few years we saw different automation solutions starting to be introduced in commercial places symbols of the major hospitality sectors: hotels, restaurants and cruises[2]. As stated before, current state of the art and adoption of service automation in the hospitality industry is an extremely limited field of research. In part due to the novelty of the topic, a significant research gap has been found which will be partially filled by this review.

4.4.1 Hotels and cruise ships

Different areas of hotel operations and customer service are being affected by the introduction of robotic and automation technologies[25]. The review, with respect to hotels, will describe examples of adoption of robotics and automation solutions divided into seven categories: Service automation, housekeeping robots, indoor delivery robots, social humanoid robots, adapted industrial robots, telepresence robots and full service automation

Service Automation

Self-service kiosks are one of the most diffused and fastest growing example of automation that has recently been implemented in hotels. CitizenM, TicinoHotels group and many others chains, independent and boutique hotels are example of companies that shifted towards the automated self service check-in/out kiosk instead of the traditional desk with human employee. According to online sources and interview videos, this choice has been driven not only by a cost-reduction need, but also, and significantlty, by customers. Modern customers want easy, do it yourself, fast and effective check-ins: time is money and operational tasks should not burden on customer experience. Marriott, Hilton Honors and others have even implemented check-in capabilities onto customer's mobile devices to further improve this particular moment of the stay.

Housekeeping Robots

Robots can be found in many different use cases performing in different departments of hotels either substituting, supporting employees and serving customers. Autonomous Vacuum cleaners such as "Rosie", produced by a USA based startup MaidBot have been able to demonstrate the benefits of innovation to several hotel operators in the States[16].

Autonomous Indoor mobile and delivery robots

Savioke is a California based startup with headquarter in Santa Clara. Their product is called Relay, an indoor delivery robot used to deliver food, drinks and requested items such as towels and toothpaste to the customer's room door step. Relay is able to navigate autonomously around the hotel, use elevators and call guest rooms phone once it has reached its destination[53]. The robot has differential drive motion and cylindrical footprint. It guarantees a good level of safety thanks to a 3d camera, a lidar sensor, sonars, a front bumper and a light weight. On the other side, Relay has a low capacity and payload. This limits its usage to scenarios where small objects have to be delivered. Savioke claims that the main customer benefits of Relay are the positive

user experience and the advertisement that it provides to the early adopters. Savioke's business model is to rent the robot on monthly base at a price around 2.000$ per month. Aloft Hotels started testing the delivery robot in 2014 naming it Botlr and customizing its appearance. Many others have followed and Savioke's first product is now used by different players in USA and Singapore hospitality business such as Marriott, Starwood and Holiday Inn [16]. Even in this case the driver for adoption has not only been enhanced productivity and labor saving, but also an enhanced guest experience. The company reports many interviews with happy hotel managers describing the advantages Relay brought them, ranging from increased revenues from hotel room service, to pervasive media coverage due to social media posts made by enthusiastic guests[16]. LG has recently unveiled three robots for the hospitality industry during CES Las Vegas on January 2018. All of them have a cylindrical footprint, a touchscreen and voice recognition features that want to add a social touch to the robot. One of them is an indoor delivery robot whose use case is totally similar to Savioke's product. Another one instead is meant to take luggages to guests rooms and perform check-ins and check-outs. The last one's aim is to scan items in stores. All three robots work on LG's ThinQ platform and can interact with TVs, air conditioners and othe compatible smart electronics. LG robots are, for now, part of a series of concept called CLOi and they are still not commercially available[28].

Social humanoid robots

Social humanoid robots are other examples of robots that are entering the scene in the hospitality industry. First of all is useful to clarify what, for the purpose of this research, we define as social robot. The following definition proposed by Fong is relevant:

"Social robots are embodied agents that are part of a heterogeneous group: a society of robots or humans. They are able to recognize each other and engage in social interactions, they possess histories (perceive and interpret the world in terms of their own experience), and they explicitly communicate with and learn from each other"[17]

A first example of social robots in hospitality is Connie, a Watson-enabled robot concierge, has made its debut at the Hilton McLean in 2016. The robot was developed by IBM and makes use of the Watson cognitive computing platform and artificial intelligence. Connie is an antropomorphic robot about two feet tall that can move its arms and legs. It communicates with Hotel guests answering their questions about hotel amenities and services and providing suggestions to customers. According to management, Connie was introduced to amuse guests and to free employees from some routinary questions, enhancing productivity and allowing staff to focus on providing real customer care[38], [53].

The Mandarin Oriental, Las Vegas, and the Courtyard by Marriott in Anaheim have been the two first US hotels to adopt Pepper, an advanced 4ft-tall humanoid robot developed by Softbank robotics[54]. Pepper's goal is to make guests feel welcome, supporting hotel properties and staff in many different ways. Pepper can interact with guests while they are waiting in line to check in, encouraging them to learn more about a property, help them find their way to the restaurant, gym or spa, or provide dinner recommendations for that evening. Pepper is also able to act as an entertainer, dancing, sharing witty jokes and posing for selfies with guests. In addition to hotels, Pepper has been adopted also in the other sector sof hospitality, namely food and bevarage. Fast foods such as Pizza Hut and Mastercard Cafè have started introducing it[29]. Here Pepper, together with collecting orders, is also able to accept payments. It is worth underlying how Pepper has been recently introduced also at Smithsonian Museum, USA[39].

Adapted Industrial Robot

Industrial robots for entertainment purposes have been present for a long time in amusement parks and fun parks, but what is now interesting for our research is their introduction in hotels and cruises ships. Royal Caribbean Cruises introduced robotic bartenders on their newest vessels: Quantum

of the Seas. Engineered in Italy, the two manipulators of the so-called Bionic Bar can muddle, stir, shake and strain all types of drinks. Mixing 2 drinks per minute, they can offer 21 cocktails and have the ability to handle custom orders created by customers at a specially programmed tablet[51]. In New York, Yotel has adopted an adapted industrial ABB robotic arms aimed at helping out customers with luggage storage before and after the checkout. The robot, made by MFG Automation, called the ABB IRB 6640, was originally used to transport materials in an industrial setting but was modified for the hotel. The Yobot is placed behind a glass wall where hotel guests can watch it in action. All the customers have to do is simply using a touchscreen and the robot will take care of storage[51]. In this case, according to interviews available online, the management of Yotl declares that the robot is not intended mainly to cut personnel, but to provide customer with an innovative, fun experience and with an higher level of service.

Telepresence Robots

Telepresence Robots are simple and straightforward products that are starting to gather acceptance and diffusion in many settings such as corporate offices, trade shows venues and even homes (Temi the Robot)[12]. All telepresence robots are basically made of a screen and a camera attached to a mobile base able to navigate autonomously in indoor environments. Telepresence robots allow for a higher level of interaction and accessibility providing an enhanced experience in video-conferences and videocalls. Many established players, as well as emerging startups, are trying to launch their products with tailor made value propositions for different market segments. Suitable Technologies is perhups the most significant player in the field of telepresence robots. Suitable technologies has recently stated to target also hospitality industry, where it aim to provide guests with a higher level of accessibility and service[45].

Full service automation

Japan is leading the race towards automation across different sectors and, among them, hospitality. Henn-Na Hotel is the first example of fully automated hotel present in different locations around Japan. Check-ins at Hen-Na Omura Bay, south of Nagasaki, are performed by robotics humanoid agents at the desk and even by a robotic velociraptor. Hen-Na features all sorts of robotics and automation perks: from automated vacuum cleaners and gardeners, to industrial manipulator to handle luggages. No humans make their appearance in the hotel. A smart autonomous luggage cart guide guests to their room whose doors are opened through facial recognition[35]. Hen-Na aims to be the most efficient hotel in the world and up to now it is the maximum expression of automation and robotics present in hospitality sector under every point of view.

4.4.2 Restaurants

The review, with respect to restaurants, will describe examples of adoption of robotics and automation solutions divided into seven categories: Service automation, food preparation and cooking robots, indoor delivery robots, social humanoid robots and full service automation

Service Automation

Food preparation and food service are the two operations in which robotics and service automations are starting to appear in restaurants and fast food chains. The ordering process has been the first process to witness the shift towards automation. Mcdonald's olive Garden, Chili's, Outback Steakhouse and many others have implemented touch screens for table-side ordering or big displays in the middle of the fast food (McDonald's) where customers can place the orders easily and fast by selecting their choices on a digitalized menu.[25] Widely diffused technologies are tablets or Microsoft PixelSense that allow customers to browse the menu, tap into detailed and articulated descriptions of ingredients and nutritional facts, place orders and even play games while waiting for their food. Different restaurants in large airports (Minneapolis) have also implemented a card reader

on the table to allow people pay directly with their cards right after the order has been placed.
The service of the food, meaning the actual delivery of the food from the kitchen to the customer is being automatized in many different ways. The most traditional and widely adopted one can be seen in conveyor or roller-coaster restaurants[25]. The first one utilize a mechanical conveyor belt and many oriental restaurants are utilizing this technology to bring small dishes of foods to the guests that are sitting aside the belt itself and can directly grab the dishes from the conveyor. There are many examples of this all over the world. Roller-coaster restaurants, instead, is a chain of restaurants that took the name from the automatic mechanical system that they use to deliver food to customers: a rollercoaster track which utilizes gravity to work. The restaurant uses a tablet installed near tables to collect orders automatically and then delivers the order through its unique rollercoaster mechanism. The concept is patented and licensed exclusively to restaurants under the Rollercoaster Restaurant brand, whose patent holder is based in Nuremberg, Germany[25].

Social and Humanoid Robots

The ordering process is also being automatized through the introduction of humanoid robots. The same Pepper Robot produced and sold by Softbank robotics that has made his appearance in some high hand hotels, is being adopted by PizzaHut to welcome guests, take orders and allow them to pay through a tailor made app developed in cooperation with MasterCard.

Indoor delivery robots

Food delivery is also a task that is staring to be "outsourced" to mobile robots. Bear Robotics is a California based startup founded by ex-Google developer John Ha that has designed Penny: an indoor delivery robot for the delivery of dishes inside restaurants. The robot has a cylindrical footprint, differential drive and no internal storage. The food is placed on a circular tray-like part on the top of a conical robot base. Bear Robotics secured an investment of 2M$ by Woowa Brothers, a South Korean food-tech firm. Bear Robotics is now testing out the robot at Kang Nam Tofu House, in Milpitas, California and has signed up the Bay Area-based Amici's Pizza chain as a customer. Bear Robotics plans on renting out Penny's to restaurants in a labor-as-a-service business model[38]

Food preparation and cooking Robots

While all the aforementioned technological innovations in robotics and service automation in restaurants touched primarily the front-office side, many back-office related process have also started to be automated. Cooking and food preparation can be seen as repetitive and routinary tasks for many businesses in the F&B sector of hospitality. Beyond food 3D printing, some dishes can now be cooked by robots. Miso Robotics is another California based startup that has recently introduced Flippy, a flipping burger robot. Miso utilizes industrial manipulators by Universal Robots, ABB and Fanuc and designed its custom picker or, better, flipper. Flippy not only can flip burgers knowing, through a combination of sensors and AI, the exact time to do it, but it can also scrub the grill-plate and put the burgers on a tray. Flippy is now working at CaliBurger in Pasadena. Miso Robotics has recently received a series B investment of 10M$ which included Levy, a Chicago-based hospitality company that runs restaurants and vending machines in entertainment and sporting venues in the U.S. and U.K. Levy looks towards staffing solutions in its heavily trafficked locations[6]. Flippy is sold at 60.000$ plus a 20% recurring annual fee for maintenance and leaning. CaliBurger has decleared ([6]) that the objectives outcome from the introduction of Flippy are, in addition to labor cost reduction, decreased waiting times, consistency and decrease of food waste.
On March 13, 2018, the Pizza chain Little Caesars issued a patent (Patent n.US009914223) entitled "Automated pizza assembly system". The patented apparatus includes a pizza sauce spreading station, a cheese spreading station, a pepperoni applying station, and a robot with a stationary base, an articulated arm and a gripper. The robot has the scope to partially automate the labor-intensive

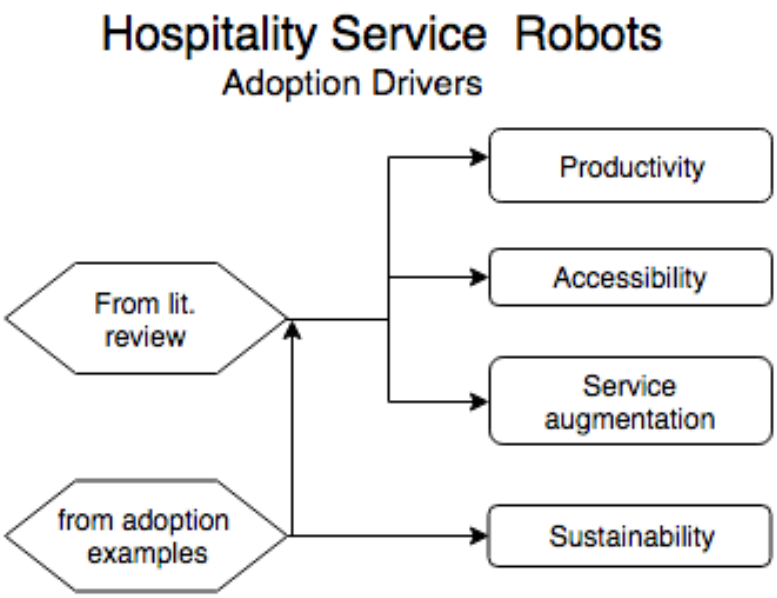


Figure 4.4.1: *HSR adoption drivers from review and adoption examples*

endeavor of pizza-making and can free workers up to perform other tasks of more added value[9].

Full service automation

A first step towards complete service automation in restaurants is represented by Data Kitchen restaurant in Berlin, the firs automated restaurant in Europe. At Data kitchen orders are requested via a smartphone app withouth the need to be physically present in the restaurant. Once the dish is ready, an app notification alerts the customer who has 5 minutes to collect the order still warm and 1 hour to take it without loosing the order. Dishes are placed behind a wall made of numbered boxes which can be opened via customer's smartphone. Behind the wall there is a real kitchen with proper chefs that work under the motto: "Slow food, fast service"[24].
A group of MIT robotics engineers from Massachussets Institute of Technology, in partnership with the chef Daniel Boulund, have just opened Spyce: a completely automated restaurant in downtown Boston, Massachussets. Chefs have been replaced by seven automated cooking pots that are able to prepare a meal in less than three minutes. The orders are placed digitally from tablets and send to an ingredient delivery system that collects them from the fridge. After having been portioned, ingredients are delivered to a robotic wok to be cooked. Once the process is complete, the wok puts the food into a bowl, ready to be served. The customers' name appears on an electronic display above their wok and he is able to collect it[46].

4.4.3 Adoption drivers

The examples of adopted service robotics solutions in the hospitality segments analyzed confirms the main drivers for adoption of these technologies are the ones described by Alexis [2] and summarized at the end of previous section. However, especially with the adoption of the burger flipping robot, another adoption driver can be identified and isolated: sustainability. In the specific case of F&B handling, automation could play a crucial role in the reduction of food waste increasing sustainability of the adopting firm. Due to the increasing importance of sustainability for all businesses worldwide, and prominently in the hospitality industry, sustainability is considered to be a fundamental driver of adoption for the purpose of our research. The updated list could be seen in figure

5. Focus group and Interviews

The previous chapter underlined the significant lack of substantial literature and research around service robots for hospitality and their adoption. The main reason is represented by the novelty of such a topic: we saw how applications of service robots are just at an early beginning. In order to provide a satisfactory and more complete answer to the first research question, empirical research is needed. The scope of this research is twofold. First, its aim is to confirm and complete the identification of adoption drivers for SR in hospitality. Second, a list of factors is one expected outcome. These are influencing factors that affect the adoption intention and ultimately the adoption of service robotics solutions in hospitality. Finally, the combination of adoption drivers and influencing factors is at the core of our conceptual model which will be used as backbone useful to steer the next part of the research. Namely, to sample the units of analysis of the case studies and to structure the data collection methods.

5.1 Focus group

5.1.1 Planning and conducing the FG

The FG conducted had the form of an expert panel. The planning and preparation of FG started two weeks in advance. The FG took place during the HITEC conference at Amsterdam in March 2018. HITEC is known as the world's largest hospitality technology event, bringing hospitality technology and financial experts and most innovative technologies to one place. HITEC is organized by Hospitality Financial & Technology Professionals (HFTP) organization. HFTP is an American global professional association for members that serve in the financial and technology areas of the hospitality industry. Members of HFTP are widely recognized experts with decades of experience in the field of technology in hospitality and the majority of them have had in the past, or have currently, executive and managerial positions in the biggest and well-renowned companies operating in the hospitality industry. The list of participants is made public through the HFTP proprietary app since the event has also a networking focus. Two weeks in advance, technology experts and hospitality managers were contacted in order to organize the FG. The targets were strategically sampled. The targets have been chosen among C-level executives which participated in the decision making process within companies who already adopted service robotics solutions, or among professionals

which work in technology providers for hospitality companies, or among hospitality industry academics. A total of six experts accepted to take part in the discussion: these are reported in table 5.1.1.

Table 5.1.1: *List of focus group participants*

	Role	Company
1	CTO	Hotel chain
2	Consultant	Hospitality technology consulting firm
3	IT Manager	Hotel chain
4	CEO	Tech hospitality startup
5	Board Member	Hospitality professionals association
6	Academia Professor	Hospitality management and Business school

The group of participants was heterogeneous. All the experts, despite coming from different type of companies, shared a common expertise in the field of technology for hospitality and managerial experience in the hospitality industry. This allowed to bring different perspectives to the table without sacrificing the tight focus and the research goal.
A brief planning and guidelines for the topics to be covered had been engineered before the FG. The list of topics that could be find in appendix has the aim of providing only a checklist of topics to be covered and guide the discussion, it is not intended to be used as a questionnaire template with pre-defined structured questions. The main overarching topic selected for the focus group was "service robotics in hospitality". This broad filed was introduced by the moderator providing an overview of examples of robotics solutions in hospitality. The introduction with concrete examples had the goal to spark the discussion and helped participants to think concretely about the adoption of these technologies. Focus group discussions lasted about 90 minutes and was tape recorded with the permission of the participants. The recording was wrote down immediately after the FG with additional notes on the interaction among participants. The anonymity of participants in the focus groups is protected in this report. In the following section the results of the FG will be analyzed and commented.

5.1.2 Analysis and results

When analyzing qualitative data in general, and FG data in particular, it is useful to group the information gathered around a set of main topics and concepts emerged in the discussion, the so called data reduction. This helps the researcher in the analysis streamlining the process and helping in narrowing down the focus on the key findings[5]. Topics and themes emerged during discussion and from the central question topic are shown in the concept map. The intensity of the arrows indicates the relevance and the attention dedicated to the linked topic. The most discussed topic has been Adoption drivers for service robotics in hospitality together with examples. Significant attention has also been directed towards influencing factors and elements that are affecting adoption of these technologies. Finally, the discussion touched with a minor intensity also ethical and social issues linked to the introduction of robotics in hospitality. Within this context, the issues of job substitution, customer acceptance, and data protection has been the most relevant.

Analysis

FG participants spent, as previously planned, a consistent amount of time and attention on extrapolating actual or possible drivers for the adoption of service robotics in hospitality together with use cases. Many of the participants, although been familiar with technology in hospitality, demonstrated and clearly stated to have only a superficial grasp of the technological complexity behind robotics. The discussion was triggered by examples of robotics technologies already adopted in hotels. The

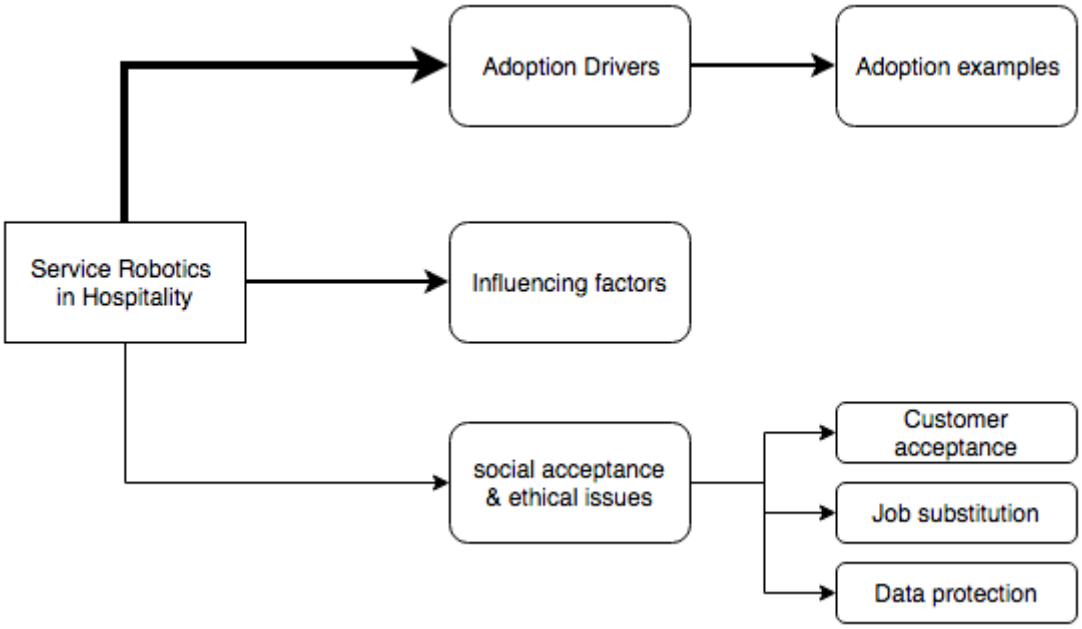


Figure 5.1.1: *Concept map of topics and concepts touched in the FG. The intensity of the arrows indicates the relevance and the attention dedicated to the linked topic*

examples shown are a subset of the ones presented in our detailed review: Savioke Relay, the indoor delivery robot; Connie, the humanoid concierge; Maidbot, the vacuum cleaning robot; ABB baggage picking industrial robot and finally Hen-na Japanese fully automated hotel. The participants recognized at first the same adoption drivers already extrapolated from literature review: accessibility, service augmentation, productivity and cost efficiency. The focal point was put around the polarization of the drivers into two main categories: front and back office. Front office refers to the customer facing activities: in some cases robots are adopted to give an added value to customer experience through elements of novelty, entertainment, or practical utility. Adoption is driven mainly by the willingness of the company to add something to the customer experience. On the other hand, back office refers to non customer facing activities: in some cases robots are adopted to cut internal costs, streamline operations, free staff from routinary tasks and generally increase operational efficiency. Participants, while agreeing that in most cases there is a combination of the two, claimed it is indeed possible to adopt SR technologies just for reaching back office targets or, in the other extreme, for strengthening brand image and differentiation. Participants were asked to position SR technologies examples on an axis with front and back office as extremes according to their perception. Participant n.3 had personally drove the adoption decision of two of the robotics examples in the company he's managing, so, the reliability of the resulting scheme is quite high.

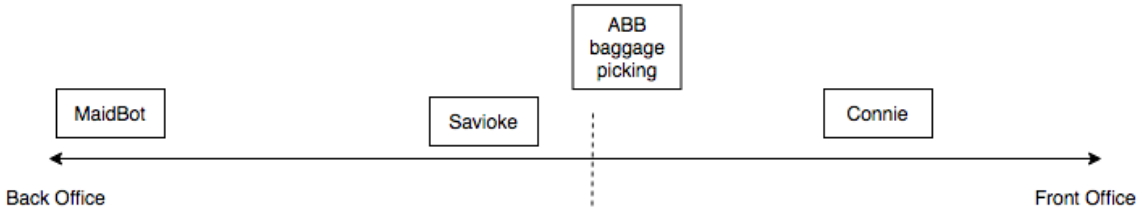


Figure 5.1.2: *Examples of SR solutions mapped along the adoption driver polarized in back and front office*

Polarization is something that will affect also the business strategies of hospitality companies, with

respect to branding and automation. Participant n.5 affirmed:

> *[...]And I also see that in the industry we'll see specializations meaning that some hotel brands will specialize in automation or not, somehow even both of 2 extremes and then the customer will decide what does it want, does it want the high touch or the high intimacy*

Additional adoption drivers have emerged in the FG discussion such as the improvement of health and safety for the workforce. Participant n.3 sees ABB baggage picking robot as not only as an entertainment gimmick for customer or an operational hep for the staff. He declared that what drove his adoption intention was also the increased safety and improvement of health derived by freeing staff members from the labor intensive and wearing task of luggage handling. Participant n.1 agreed and reinforced the argument expressing the need for robotics solutions that help in avoiding staff injuries which is a big issue especially in the US. This sparked the discussion around job substitution and relationship between human and robotics workforce. New drivers of adoption and influencing factors emerged from the discussion. Reduction of labor turnover is seen by the participant as a great potential driver for introducing robotics technologies, influenced by the labor shortage that is affecting hospitality. Participant n.1 quote is relevant:

> *The truth now is that we, as hoteliers and people hospitality managers are having a really hard time finding these people, this workforce, the turnover is exceptionally high, they get injured they get sick, and then we got problems. So the reality is that we are not arriving to a point that we will replace every job yet, more likely honestly some jobs will be replaced and we will have the opportunity to repurpose funds into other things. Labor shortage is a real issue in our field and robotics introduction in hospitality can be partially driven by the goal to overcome this*

Among influencing factors, there are also policy and governmental actions that are affecting the adoption of robotics technologies, especially when it comes to the job substitution issue. Participants n.6 mentioned the public grants and funds made recently available for hotel companies that are introducing automation technologies in order to absorb job substitution. Hotels are on one hand incentivized on adopting automation, and on the other hand the funds give them the opportunity to train the workforce and move it towards knowledge management processes. I A relevant topic covered at this stage has been the high initial investment costs usually related to the introduction of robotics technologies. According to the panel, these factor, together with the resulting high switching costs, are hampering diffusion of service robotics in hospitality, which is a business characterized by low liquidity. These insights are extremely relevant for the subsequent part of our research when the conceptual model will be used to structure the cases and business model design recommendations. Issues of robot taxation and regulation have been scratched at this point, together with other social and ethical issues. The discussion, while slightly going off topic, resulted in the identification of more influencing factors. Regarding social acceptance, a relevant intervention by participant n.4 is worth being reported. Participant n.4 was directly asked about the reaction of the customers to the adoption of Savioke's Relay indoor delivery robot:

> *It was a very positive feedback, enthusiastic, many people posting on instagram and social media, we got a lot of press coming by: a wow effect. If over time the robot gets expensive, for example there's some maintenance needed and so on, it is important to evaluate the long term ROI*

In the end, the discussion was directed by the moderator towards the innovative propensity of hospitality industry to extrapolate final useful influencing factors of adoption. What resulted is

that hospitality industry has never been a technology early adopter. Service robots for commercial spaces, on the other hand, seem to have found fertile ground for being introduced in the market in this industry. This does not come at a surprise according to the expert panel. The reason lies exactly in the low familiarity of hospitality with groundbreaking technologies. Hotel managers in some cases are introducing robots just because of a feeling of backwardness and a felt urgency of being innovative. To close the panel, participant n.4 affirmed, on this, giving also a precious tip for new tech ventures in the field:

> *we should be aware that what we are demonstrably good at doing in this industry is solving problems that we don't have with technology that nobody wants. You see a lot of startups come and go for this. It's happening a lot. I think at the end it robotics is gonna come up. But the hospitality industry is a big industry but it is narrow enough to prevent somebody to invest several millions to develop something just for the hospitality: an industry that is denotably not early adopter, it's suicidal. You gotta spread across for sure in order to survive*

To summarize the content and the key takeaways it is useful to list all the adoption drivers and influencing factors that have been extrapolated until now. Table 5.1.2 shows the list of adoption drivers and influencing factors that are affecting adoptions extrapolated from the focus group.

Table 5.1.2: *Drivers of adoption for service robotics in hospitality and factors influencing adoption*

Source	Adoption Drivers	Factors influencing adoption
Literature review	- Cost efficiency - Accessibility - Service Augmentation - Sustainability	
Focus Group	- Health and safety improvement - Labor turnover reduction - Strategic differentiation	- Labor shortage - Initial investment - Switching costs - Brand image - Target customer - Innovation propensity - Regulatory environment - Public incentives

5.2 Interviews

Interviews were conducted chronologically after the focus group. Planning started a week in advanced and the participants were selected among experts with a teaching and research position in one of the most well renowned hospitality management and business schools worldwide, which we will name "Institution L". All the three interviews had been electronic through Skype: the experts were based on a different country with respect to the researcher and the costs to reach personally the interviewees were too significant. Skype calls were recorded with consent of the participants utilizing Callnote software free and the recordings have been transcribed immediately after the interview. Interviews took place in an unstructured manner, only a brief list of topics to be covered has been used as a guideline. In the next subsection, the interviews data will be analyzed an results will be extrapolated. Table 5.2.1 provides a list of the interviewees and their roles.

Table 5.2.1: *Interviews participants preliminary research*

	Role	Academic Institution
1	Professor and Head of Entrepreneurship and Innovation Department, Holder of the Food & Beverage Chair	Institution L
2	Associate Professor of Service Management, Director of the Institute of Business Creativity	Institution L
3	Senior Lecturer with expertise in luxury hospitality management	Institution L

5.2.1 Analysis and Results

Interviews analysis will be performed in an aggregated manner. The main topics emerged in the three interviews will be identified and aggregated to reduce the data. this step has been done through coding following guidelines proposed by Burnard[8].

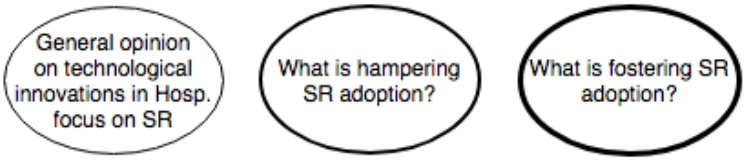


Figure 5.2.1: *Conceptual map: main topics covered in interviews*

Transcripts were read again and again and relevant concepts were underlined together with summarizing takeaways. Generally speaking, at an high level, three main topics were covered in the interviews and interviewees were led to spend time towards generating ideas and elaborating argumentations around these topics. First, to start the discussion, the focus was put on a general overview of interviewee opinion of technological innovation affecting hospitality, with a focus on service automation and robotics comprising trends and examples. Second, discussions were directed towards what is hampering automation technology adoption and what is instead fostering it in hospitality. Through the whole interviews, the interviewee were challenged to provide justifications and strong argumentation to back their affirmations. The topics are reported in a new conceptual map in which the thickness of the circles reflect the time and focus spent on each topic.
In the analysis of the interviews transcripts,hree main concepts emerged naturally from all three interviews and have been coded. These three categories, namely:

- Inherent uncertainty
- Job substitution and management change
- Customer centricity

Were not the only important takeaways from the interviews but represented the first step in data aggregation and "open coding". Table 5.2.2 summarizes the categories emerged in first open coding and reports relevant script parts linked to those categories.
An in depth analysis of the transcripts led to the definition of other and new relevant concepts. These concepts were not found in each of the interviews, but were judged relevant for the research; the inteviewees have mentioned those multiple times and argumented strongly around those concepts. *Unprofessionality* of the actual managerial class in hospitality was mentioned several times by Interviewee n.1 and reported as one of the causes of the difficult relationship between new technology adoption and the hospitality industry. A concept directly linked with unprofessionality mentioned by interviewees was the *Complexity perception*. It has been mentioned how the low level of training of the managerial class makes technology, and especially robotic, be perceived as enormously complex and distant from reality. Several examples have been brought. Many professionals wrongly think that the adoption of such technologies requires not only capital intensive investments, but also

Table 5.2.2: *Open Coding and data reduction of interviews*

Transcript 1	Transcript 2	Transcript 3	Categories
in hospitality we have very often incremental innovation, disruptive innovation is really dangerous because of timing: too early, you die, too late, no point. Investment in hospitality are very high at the beginning and low margins so you have to be careful. for example in the 90s we had ethernet, and we had a lot of hotels that wanted to have ethernet connections in room doing a lot of big works to do that. And couple of years later the wifi came, only 10 years later you have wifi everywhere. so they did not have a ROI.	It is very difficult to be sure that you have done the right choices. Technology is moving quickly and yo know.if you start too early you have some issues but if you start too late you have others. it is really hard to decide which is the most appropriate technology to be adopted at the right time. you do not even know wether the customer will use those	When deciding on adoption of new technologies, we need to ask very serious questions. How can we anchor that strategically into our business? It is not an easy question to answer because of the uncertainty of these decisions. How could you forecast a ROI? How could you know wether the customers will use that?	***Inherent Uncertainty***
That's of course really hard to evaluate in the long run weather the coming boom of automation in our industry will eventually have apositive or negative impact on employment. But the truth now is that we, as hoteliers and people hospitality managers are having a really hard time finding these people, this workforce, the turnover is exceptionally high,they get injured they get sick, and then we got problems. So the reality is that we are not arriving to a point that we will replace every job yet, more likely honestly some jobs will be replaced and we will have the opportunity to repurpose funds into other things. So, while we may be creating robots that one day will be able to clean the entire room and fill up a minibar way faster and better than any human could,, we are ages away from that still. So ultimately is not my real concern today about job substitution because that's something that will happen one way or another, and anybody is lying to themselves if is saying that this won't happen	Something that will happen with robotics in hospitality is job substitution. It will happen, one way or another, so, we have to accept that. But what will happen together with this is a big generation change in management in hotels.now you have baby boomers and they will leave, you'll have generation X and Y, and i t hink this will drive a lot of decisions in favour of robotics and automation. More and more the managers of the hotel are more professional, more managerial skills, with substantial business education. They will be able to evaluate better adoptions and make better informed decisions to tackle the 3 challenges of hospitality industry: attract new customers. the second is to satisfy them and 3rd them is to manage cost	New jobs are coming into hospitality. There is the need to bring back the experts to this business. Over the last decades cost efficiency and unprofessionality have come abruptly into hospitality. Many hotels are run by untrained and low managerial/technological skilled people. Technology can be an important ingredient leveraged by the new wave of experts. What really changed the world is technology, of course many things such robotics will also lead to job substitution but I see it both as inevitable and auspicable for the situation of hospitality industry right now.	***Job Substitution and generational change***
What is the customer point of view? Are they happy to be surrounded by robots? This is the real question to ask because in our industry everything rotates around customer experience and we cannot avoid thinking about that. Customer is at the core and every decision should be t aken thinking about him	So again it depends on your customers ultimaly. you need to satisfy their expectations. If you want to adopt robotics in hospitality has to be done very smartly. You always have to think if there is an added value for the customer, not only for an operational point of view. You have to think always that if you want to introduce robots and automation you have to deliver an added value to your customer. if you are able to cut costs and add value to customers, this is the recipe for success for robotics in hospitality	There are many hotels that are implementing automation and a lot of technology to simplify the processes. But the main question should be, what can we do with robotics and automation that can add value than a human do? or that can created a better service for the customer? the customer is at the core, always, and the general trend of the industry is to personalize everything. Most likely I think we'll never see automation coming just to cut costs, the added value for the customer is crucial and needed	***Customer Centricity***

significant changes to the facilities infrastructure, both from a construction point of view as well as with respect to the IT infrastructure. In many cases these modifications are not even required and the integration costs and efforts are extremely low. The wrong perception in this sense is a factor that is hampering technology adoption in hospitality, especially robotics. Two out of the three interviewees underlined also another issue under the managerial perspective: the hospitality *ownership structure*. The wide majority of hotels or restaurants are run independently and are family owned businesses. In this landscape, for technology diffusion is difficult to take off. Also when we are talking about international chains with hundreds or thousands of point of sales, usually the ownership is really fragmented, divided into franchisees in some cases, or among different big multinational companies. The decision making process does not run smoothly in a such fragmented environment and this is a factor that influences enormously adoption and diffusion. Finally, *location* was indicated explicitly as an important influencing factor. Location is often deeply inked with target customer but it can be a significant element that affects robotics adoption intention. For example hotel room service is a much more relevant business for resorts located in quite remote places far from cities where the choice of restaurants is very limited and the customer is somehow forced to eat in the hotel facilities during the whole period of stay.

5.3 Discussion

The conclusion of first empirical research led to significant new insights. Empirical research indeed proved to be useful and and Its result provided further in-depth knowledge which was not acquirable through literature review or desk research. Most of all, it was crucial to extrapolate and identify the relevant factors that are influencing adoption of service automation and robotics in hospitality industry. First, it is useful to present a summarizing table 5.3.1 listing all the factors and adoption drivers emerged up to now.

Table 5.3.1: *Complete list of adoption drivers and factors emerged from desk and preliminary field research*

Source	Adoption Drivers	Factors influencing adoption
Literature review	- Cost efficiency - Accessibility - Service augmentation - Sustainability	
Focus group	- Health and safety improvement - labor turnover reduction - Strategic differentiation	- Labor shortage - Initial investment - Switching costs - Brand image - Target customer - Innovation propensity - Regulatory environment - Public incentives
Interviews		- Inherent uncertainty - Management change - Location - Ownership structure - Unprofessionality - Complexity perception

Factors have been presented and explained along the analysis of results, in this section, we will elaborate on findings according to our conceptual model in order to structure the next core part of

the research. If we refer to the TOE framework presented in the initial literature review, it is indeed possible to categorize the emerged factors into the distinct macro areas of Technology, Organization and Environment. Adoption drivers and factors will be used to structure the case studies. Drivers of adoption, in our research, refer to the value proposition block of the Business Model Canvas. At this stage, it is possible to conclude that among the different drivers identified, three play a key role in modulating adoption intentions and are the strongest one, namely:

- Cost Efficiency (+ productivity)
- Service augmentation
- strategic differentiation

It is important to underline how, at this stage, we are already able to give a first general recommendation about value proposition design: a value proposition would need to incorporate one of all three drivers in order to be effective. However, we will test this within the case studies. As emerged from focus group, it is possible and useful to summarize the drivers and visually present them in a polarized manner. Cost efficiency (or enhanced productivity) refer to Back Office operations in the hotel and more generally to those tasks or processes which are non customer facing. Drivers related to adoption are just focused on internal goals of the firm who adopt the robotics solution. On the other hand, Front Office (FO) summarize customer facing processes and services. Service augmentation and Strategic differentiation are drivers which fall under this category. This polarization will be used as a guideline to sample units of analysis for the case studies.

Table 5.3.2: *Factors categorized according to TOE*

TOE Framework	Factors
Environment	- labor shortage - Management change
Organization	- Brand image - Target customer - Innovation propensity - Complexity perception - Location - Initial Investment - Switching costs
Technology	- Inherent uncertainty

Figure 5.3.1: *Polarization of adoption drivers*

Finally, not every factor will be considered in the further step of the research. Since the research problem is not limited to a certain geographic area, and neither the goal, factors referring to regulatory environment and public incentives will be left out. These factors depend heavily on the countries and regions in which hospitality company operate and their analysis would not be reasonably comparable. A summarized list of factors taken into consideration, mapped out following TOE framework is presented in table 5.3.2

6. Case studies: Analysis and results

In this chapter, the analysis and results of the case studies will be presented. The strategy for sampling the units of analysis will be explained in details and each case will be analyzed individually. Finally, results emerging from the four different cases will be compared through a cross case analysis. It is important to mention how case studies have been structured based on findings from review and preliminary research. TOE framework, adapted for the specific case of service robotics technologies for hospitality industry provided represented the backbone of the cases. This has been done in order to ensure ex-post validity for the case study research.

For the purpose of our research, case studies have been conducted in order to solve the practical research problem and reach the final research goal, which is giving recommendations specifically to Tactile robots business model design. For this reason, in order to be consistent with the research goal, the theoretical framework developed to structure the cases have been complemented with an additional specific investigation on the desirability of service robotics solutions for automating hotel room service among the potential customers strategically sampled.

The case studies are structured in this manner. First, adoption drivers emerged have been used to sample the units of analysis. More cases have been conducted with respect to the ones reported here, however, the four cases analyzed in the next section have resulted the most instructive and relevant ones. The analysis proceeds starting from a general description of the company studied. Subsequently, company strategy, target customers and positioning have been investigated and are reported. Specific relevance and emphasis has been put on hotel room service and its impact on analyzed company' business. Finally, a factor analysis is carried out for each company. We analyze which of the factors influencing adoption of service robotics solutions emerged from preliminary research are in place for each company. Subsequently, we present which is the influence of each factor on the adoption intention: weather it is positive or negative and how strong and relevant it is. A score ranging from -5 to +5 has been given for each relevant factor. Negative scores mean that the single factor is having a negative influence on adoption intention, while positive scores represent a positive influence on adoption intention. Factor analysis and the scoring has been performed by the researcher. The outcome reflects its judgment regarding how the interviews outcome translate into the score for each factor.

Finally, a cross-case analysis is done that allow us to compare results of positioning, strategy, target customer and factor analysis in order to extrapolate meaningful conclusions.

6.1 Sample

Sampling is of major important for our research. As we learned from literature review and mostly from preliminary research, hospitality industry is really fragmented. Many hotels differ in a number of metrics such as ownership structure, range of business, location, rating, target customers and so on. Selecting a reasonable representative sample for the purpose of our research is thus not an easy and straightforward task and required a significant effort of preliminary research and analysis. As it has been mentioned in the research design chapter, the choice of the sample for the cases, namely our units of analysis is deeply linked with the final research goal. Units of analysis, in fact, represent the target customer segments identified which populate one of the three business model canvas building blocks that are under our research focus.
After having extrapolated the main drivers of adoption for service robots in hospitality, we learned how the three drivers are at the very core of adoption of these technologies are:

- Cost efficiency
- Service augmentation
- Strategic differentiation

These can be further summarized by polarizing them in 2 different categories: back office (BO) and front office (FO). This polarization that emerged from theory and preliminary research is at the basis of our sampling strategy. First, we want to pick up a sample as diversified as possible with respect to drivers regarding front office and Back office. Second, we want to select units of analysis in which these polarized drivers are strong and felt. This strategy allow us to restrict the sample to four hotel companies which are the most representative for the different customer segment niches. Table 6.1.1 lists the companies selected.

Table 6.1.1: *Companies sampled as units of analysis*

Name	Ownership structure	Employees	Regions
Company A	Centralized Chain	250<500	Headquarter NL, op: EU, ASIA, US
Company B	Multinational franchised chain	150 (Franchisee)	Worlwide, NL franchisee
Company C	Local Chain, family owned Holding	400	NL
Company D	Indipendent Hotel	900	Mekah, Saudi Arabia

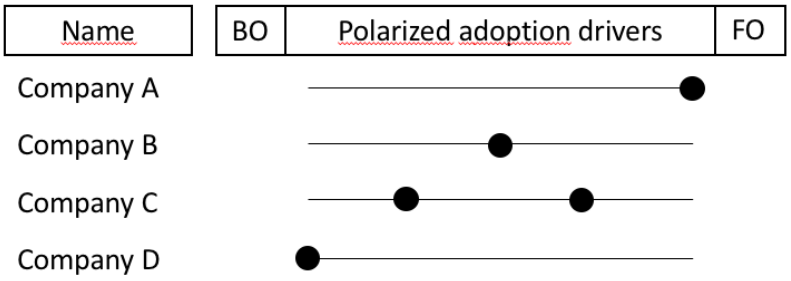


Figure 6.1.1: *Sampling of units of analysis according to polarized adoption drivers*

Figure 6.1.1 depicts the sampling according to the polarization of adoption drivers. Company A has been selected to to the presence of Front Office drivers, meaning that the company is motivated to adopt service robots with the aim to augment customer service or strengthen brand image. On the opposite, in Company D the only adoption drivers in place are related to Back Office: increase

productivity and cut costs. Company B offers a balanced compromised of both FO and BO adoption drivers. Company C, finally, could have a mixed motivations to adopt service robots depending on the specific hotel owned as it is non standardized family owned holding.

6.2 Company A

Company A is a Netherlands-based hotel chain owning a total of 12 Hotels worldwide distributed as follows: 1 Asia, 1 in US and 10 in Europe with plans of rapid expansion both in Europe and US over the next few years. The company, founded in 2005, opened its first hotel at Amsterdam Schipol Airtport in 2008 and subsequently expanded in UK and France. Today, company A counts a total of about 400 employees distributed among the central headquarter in the Netherlands and the hotels which are part of the chain. According to the founders, Company A was born out of a sense of frustration coming from the absence of boutique hotels at an affordable price.
Company A was launched after a wide market study and a wanted to revolutionarize the industry bringing something different to market. Company A has a NL based Headquarter which provides 24/7 remote assistance to every hotel since no tech or operational personnel is employed in the hotels.

6.2.1 Positioning, Strategy and Target customers

Company A is positioned in the emerging market niche of Affordable Luxury Boutiques hotels, targeting new generation of travelers and offering an informal, personalized and innovative service. As mentioned by Company A CTO, the company does not like hotel ratings and aims to obtain at least a 4 stars rating for each one of its hotels just because of the relevance of ratings for booking engines such as Booking.com or Expedia.com, which are the major source of bookings today.
Company A targets young generations of travelers. The ideal target customers are young people in their twenties or thirties with a job. According to Company A, their segment is the people who have just finished studying for example, that once they get a job are really likely to immediately start traveling to discover the world. These generation are different from others both in the traveling habits as well as in their attitude towards people and technology. Company A target customers are in search of easy, accessible accommodation that make them feel as comfortable and informal as they were at home. They expect a certain amount of luxury in the ambients and a really convenient, informal service at an affordable price. Company A target customers expects to be treated informally and looks for contact with local traditions and cultures to enrich herself.
Company A strategy is to be perceived as strongly innovative and young, it deploys a peculiar and innovative business model which represent one of its major elements of differentiation. The whole business model could be summarized in having the minor number of people possible on site with the only task to provide customer service. The people employed by company A, in contrast with the common practice in the industry, usually do not have any formal education or training in hospitality and have not worked for hotels before. Company A employs its staff based on the ability of being socially pleasant, kind and open minded. After having been selected, the on-site staff members are sent to a 20 days training program in one of the operating facilities and receive personalized and customized brand training.
Company A is highly standardized in all of the traits of the different hotels: from facilities interior designs, to available services. According to Company A marketing manager this is both a major source of competitive advantage as an element of weakness:

> *If you walk into our hotels in Taiwan, London, Amsterdam, you will get same feeling. We've been a very successful company in part because we did that extremely well. But what it also means is that it gets boring over time. If you love it, fantastic, but if you are looking for something more novel over time, we are not for you, nothing sexy*

is happening anymore. Our sexyness is awesome but not scalable. We've worked out this many ways to avoid this. And our innovation strategy is meant to overcome this.

This quotation introduces the theme of innovation and innovation propensity of company A, which is one of the most important influencing factors we take into account in our case studies.

6.2.2 Innovation drivers

Company A is focused on being perceived as innovative by its target customers, so, innovation in the model and technological innovation play a key role in the whole business strategy and business model. The whole company concept emerged from an urgency to innovate the sector of hotels which had remained basically untouched and substantially unvaried for decades. Company A has already significant technological innovative elements in its hotels. Every hotel was designed with automated check-ins checkpoint with touch screens. The whole process of check-in is automated and made as fast and easy as possible. In one of the interviews Company A elaborated on the two main drivers for the innovative activities of the company: Convenience and personalization.

We've looked into what drives innovation today. and we went through many iterations. What drives us today is a big move towards personalization and convenience. There's a vision for example to remove the check-in completely.[...] Convenience is one big driver of our future ideas. The other one is personalization, personalization is that you walk in front of checkin kiosk (but we want to remove it), it can switch to your language, facial recognition or whatever. we know your preference of rooms and everything. when you walk into the room we now have a massage, but we can personalzie content for you on netflix and so on. The technology to do all of this needs a lot of integration at the back.

Drivers of innovation for company A seem to be significantly unbalanced towards Front office innovation, in accordance to the sampling strategy decision. However, interviewees have been asked specifically about back office innovation . While confirming to be looking for every possible way to optimize and automate back office processes, they all agreed that their focus with respect to innovation is adding value to customers or strengthening brand image. It is again useful to report the words of the CTO:

we are a very customer driven company. Of course we cannot ignore stuff at the back of house, there's also money there, but these are costs , but we focus on revenues. We also look for a lot of solutions at the back to automate as much as possible, but we always think which is the added value for the customer.

Restricting the focus to service robotics technologies, Company A declared to have investigated the possible adoption of service robots in the recent past. Specifically, they wanted to implement the same baggage tolling robot adopted by Yotl Hotel and described in the chapter about adoption examples. In this case the main driver for adoption would have been a strengthened brand image.

It is cool! It enhances our brand in someway. Our guests are kind of teck gimmicks. One of our popular thing in the hotel is RGB light, we have a light in the bathroom that can change colour, guests really appreciate that, it's fun. especially the first time. it's a gimmick but it's fun and it's what we do, it's our brand, a robot for luggage is good for that.

In second place, the robot would have been useful for the personnel to avoid the time consuming and wearing task of handling heavy baggages. Moreover, it has been underlined how the frequent

receiving of parcels from customers is beginning to represent an issue for hotels belonging to the chain. The ABB robot would have come beneficial in many ways and we see many of the drivers identified previously in place for this specific solution. However, the decision to adopt it was finally turned out due to the big encumbrance of the robot. Company A could not sacrifice such a big amount of real estate space for a similar product.

6.2.3 Room service

Company A does not offer hotel room service among its standard services. This decision is aligned with the brand and its target customers habits. Purchasing is not a big part of the business and the whole concept of Hotel A does not rely on the restaurant, which is not in place even. Food is seen as a must have for guest convenience and is offered in simple items available 24/7. Target customer of Company A is expected to eat outside and discover the cities. On the other hand Company A receives a discrete volume of orders of toeletries and small items from guests. Company A CEO declared to have started investigating the usage of indoor delivery robots for solving this problem that sometimes is loading too much on-site employees. A mojor driver for the adoption would still be the strengthening of brand image, on top of operational efficiency

6.2.4 Factor analysis

Company A						
Factors	Present	Strongly Hampering adoption	Hampering adoption	Neutral	Fostering adoption	Strongly fostering adoption
Labor Shortage						
Management change						
Unprofessionality						
Ownership structure	■					X
Complexity perception						
Inherent uncertainty	■		X			
Location						
Innovation Propensity	■					X
Brand image	■					X
Target customer	■					X
Initial Investment	■		X			
Switching costs	■		X			

Figure 6.2.1: *Factor analysis for Company A*

Regarding innovation propensity, Company A defines itself as "Leading Edge adopters". Despite being at the edge of hospitality innovation, Company A maintains a certain amount of risk aversity.

> *we defined our tech mission as "Leading edge adopters" we don't necessarily want to be the first in the world, but we want to be the very first once it works. ABB robot might be a good example, Yotl took the risk of doing it, if we are adopting it we will be the second, but still ahead 99.9% of the industry.*
>
> Company A CTO

Company A thinks that major factors for the hospitality industry in general that is the fragmented ownership structure. The centralized ownership structure of Company A is, instead, really fostering adoption of technological innovation. Interviews also confirmed the cultural issue that is

present in hospitality with respect to technology adoption, which we translated into the factors: unprofessionality, complexity perception and management change. Finance related factors have a small influence for company A which possess relatively high investment budget and investment propensity. Interviewees have been asked to elaborate on the last technologies adopted and the payment model used and the general preferred payment method. Company A overalls prefers to adopt technologies through leasing models without too high initial investments and above all in order not to have significant switching costs in the future. They want to be able to change and implement new things that replaces old without financial stress, when possible.

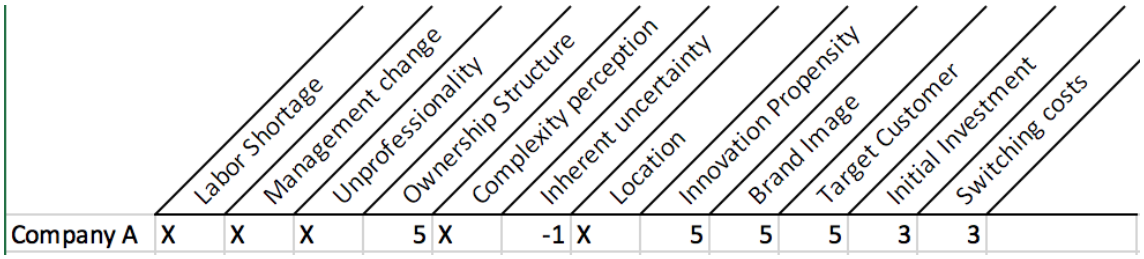


Figure 6.2.2: *Ranked Factor analysis for Company A*

Figure 6.2.2 Summarizes the factor analysis for Company A. Due to the peculiar business model and employee strategy, human and labor factors are not in place for Company A. The company does not recruit trained personnel, so it is not subjected either to labor shortage or management change or unprofessionality of employees and management. The strong technical department of Company A makes also complexity perception not relevant. On the other hand, the brand image of Company A, together with its young and tech savvy target customers result in a high score for the linked factors. These are significantly pushing Company A to adopt technological solutions aligned with brand and customers. Finally, investments and liquidity are favorable to introduction of technology, thus have a positive score.

6.3 Company B

Company B is a well renowned multinational Hotel chain active in 127 countries worldwide for a total of 6520 locations. It manages and franchises a broad portfolio of hotels and lodging facilites. It was founded in 1927 in Washington, US and it is a NASDAQ publicly traded company. Company B has an annual revenue of about 22.8 Billion dollars and counts a total of about 177.000 employees worldwide. As of September 2017 Company B counted a total of 1.2 million rooms available worldwide. It is important to underline how Company B had been the first hotel company worldwide to offer guests the option to book reservations on-line in 1995.
In this research, we narrowed down the scope to a single representative franchisee of the chain based in Rotterdam, NL. From now on, we will refer to this franchisee as Company B. This specific Franchisee was opened in 2016, while before that the same building hosted an independent hotel run by part of the actual management. The opening of the franchisee determined a series of activities in infrastructure and operations required to align with the franchising brand. Company B now employees about 150 people.

6.3.1 Positioning, Strategy and Target customers

Company B is, as mentioned a franchisee of an multinational hospitality company with a renowned, established and trusted brand. All the hotels of the brand have a 4 star rating or superior, Company B has a five star rating. The positioning is called by Company B as "Classic Premium" and reflects the most diffused positioning of the franchising brand. Company B' franchiser can be seen as one

of the founding fathers of traditional hospitality with a great history and tradition in putting people first using integrity and people's comfort as core values. Company B target customers are really diversified and coming from different population and demographic groups. Business men that travel for job related obligations, families that travel for pleasure and small groups of friends as well as individuals for touristic purposes. However, in the last years one target customer in particular is on the focus of Company B, who it calls the "Inventive Class". F&B manager of Company B expressed clearly this idea during an interview:

> *we focus on a target guest that we think is also inventive. younger generations with a lot of travel experience. we have many guests from US and UK, i think about 55% of our total guests we have. They are familiar with traveling, they travel a lot and they think that traveling expands their ideas of the world. we call that target group the "Inventive class". Today we are trying to focus on them on all the steps of their journey.*

B's strategy thus poses a significant focus on younger generations of travelers, millennials and generation Y: tech savvy people in seek of a new form of more convenient and simple luxury, technology enthusiast and most of all open to discover the world and be contaminated by local cultures.

6.3.2 Innovation drivers

Company B, despite belonging to one of the most traditional hotel companies in the world, has an innovative DNA. It is useful to remind how company B franchiser had been the first to introduce on-line booking system back in 1995. Innovation is a core element of the company, not completely focused and limited to technological innovation. Company B puts significant focus on innovation of processes and experiences. As reported by the management, a recent innovation adopted had been in the meeting concept:

> *It is not solely about thechnology, but it could be merely about thinking innovative ideas and delivering innovative experiences and services to customers, regardless of technology in itself. One example is the meeting concept that we have at in all hotels of the franchising. In traditional hotels they receive a call from a company they want to have a meeting and then they ask how many people, which setup do you need etc etc. Whereas in our case, when we have contact with company we only ask which is the meeting purpose and then we figure out how to build everything on the background. and develop the program for the guest, in terms of setup service experience and tehcnology. we try to think what the guest need before them.*

Regarding more technological innovations, recently Company B has adopted a technology that was introduced in all the hotels part of the chain: automatic mobile check-ins. This feature allows guests to check-in on the day of arrival even before entering in the hotel thanks to the brand app and system integration with the PMS (Property Management System). Company B management did not resulted completely well informed about the details of the technology and drivers of adoption since they just complied with brand standard and adopted the technology provided by the Franchisor. Company B management, however, declared when interviewed that they are in seek of technology that can have significant impact both in the back and front office. While they are customer focused and they aim for providing added value to customer, they have an increased need of cost efficiency and streamline operations. While another Franchisee belonging to B Franchisor has adopted one of the robotics solutions described in chapter 3, Company B has not yet tapped into robotics. Personalization is the most significant innovation driver as stated by B. The overall goal is to be able

to personalize as much as possible the service for each individual customer. This entails significant data collection and analysis.

6.3.3 Room service

Room service represent a core service offered by Company B 24/7, aligned with the brand, necessary to maintain the rating and used to convey an experience to customers. Management mentioned how RS grew significantly over the last two yeears. According to F&B manager, this is due to the change of type of the average guest: international American business guests is the type of guest most likely to order HRS. In addition, also the so called "Inventive class" guest makes use of RS. While preferring to eat outside of the hotel exploring the city, Company B guest, when decides to stay in hotel to eat, prefers ordering room service. In the first 3 months of 2018, Company B received about 2552 orders, averaging 20 orders per day. B declares that the order volume is extremely variable and difficult to predict. It depends on seasonality and most of all on customer types. Room service does not generate significant profit for Company B while being a costly service to be maintained in place. Items are priced at the same level of the restaurant but a room delivery fee of 4,50 Euro is applied as a markup for the service. The fee is meant exclusively to pay back the direct labor costs of the service. Room service has dedicated personnel employed exclusively to perform deliveries in rooms in shifts. So, more than one resource is employed just to bring dishes from kitchen to the guest room. Orders are take through phone, while there is an intention to switch towards smart TV order system. This is intended to avoid misunderstandings and help in data collection and tracking. Company B reports an increasing demand from guests to receive orders of food from external food delivery services like Deliveroo. In these cases, orders are coming from different restaurants in the surrounding ares. This is allowed but not encouraged from the hotel since it of course does not generate revenues for the hotel and it increases the amount of rubbish and workload of the housekeeping staff. Company B hopes one day to find a way to monetize from this kind of requests.

6.3.4 Factor analysis

Company B						
Factors	Present	Strongly Hampering adoption	Hampering adoption	Neutral	Fostering adoption	Strongly fostering adoption
Labor Shortage						X
Management change					X	
Unprofessionality						
Ownership structure		X				
Complexity perception		X				
Inherent uncertainty		X				
Location						
Innovation Propensity					X	
Brand image					X	
Target customer						X
Initial Investment			X			
Switching costs			X			

Figure 6.3.1: *Factor analysis for Company B*

Company B suffers significantly from labor shortage in hospitality industry. Due to brand, standard

and positioning, B relies on highly qualified human resources which received adequate training in the hospitality sector and which usually have significant experience in the field. However, Company B reports a significant labor shortage and a high turnover. These factors reflect in higher costs for the company and the need to automate some processes or tasks. Being a traditional and established hospitality company, B is now in a process of managerial generational change. However, this factor is impacting more on the Franchisor than B in itself since it has already went through this process over the last two years. The shift in managerial class towards a younger, trained, tech savvy generation is fostering adoption of new technologies. Ownership structure of B Franchisor is extremely fragmented and diversified. This could hamper adoption and diffusion of new technological solutions. On the other hand, B, as a Franchisee, can benefit from a degree of freedom and independence from brand standards and have a discrete amount of purchasing and decisional power.

	Labor Shortage	Management change	Unprofessionality	Ownership Structure	Complexity perception	Inherent uncertainty	Location	Innovation Propensity	Brand Image	Target Customer	Initial Investment	Switching costs
Company B	5	3	X	1	-1	-2	X	3	4	5	2	2

Figure 6.3.2: *Ranked Factor analysis for Company B*

The propensity to innovate is high as a whole, and it is fostered by the new target customer type now on the focus of B. B brand is not directly linked with technology, but can be strengthened by robotics solutions which are aligned to brand standard. Initial investments and switching costs are important factors in place that are hampering introduction of robotics technologies. According to Company B management:

> *if I had to choose i'd lease everything, every new technology we adopt, because we usuallly do not have a lot of liquidity which can be spent easily on these kind of investments.*

Figure summarizes the factors and their scores for Company B.

6.4 Company C

Company C is a independent hotel chain comprising a total of 15 hotels distributed across Netherlands only for a total of 1300 rooms. The hotels vary in size ranging from 80-100 rooms of the small boutiques hotels to the 210 rooms five stars hotel in Scheveningen beach. Revenues for the whole group touch 30 million annually. The management board of C is composed by three people, two of whom are member of the family which owns the holding company proprietary of the hotel chain. Company C represent the typical independent family owned hotel company. C is thus representative of the most diffused type of hotel and ownership structure present worldwide. Company C was born as a real estate family business investing in retail premises and small office properties. It turned one property into a hotel in 1998. Today, Company C employs a total of 450 people, half of those on a part-time basis.
C properties differ significantly from each other and the hotel chain has no elements of standardization in place: each hotel is managed independently, has its own rating, personality and style.

6.4.1 Positioning, Strategy and Target customers

Company C has been chosen as part of the sampled units of analysis especially for its peculiar ownership structure and its intrinsic diversity among the different hotels belonging to the chain. These aspects reflect the most diffused example of hotels present worldwide. Company C has not a clear and defined brand image and it is not part of an established or recognized brand in hospitality. The 15 hotels have rating ranging from 3 to 5 stars and have the common characteristic to be positioned in central locations. Amrath mission is to provide high level of comfort and service to customers in friendly and informal environments, with good restaurants and bars. Each hotel is designed to reflect the local history, culture and traditions. A certain number of buildings are declared national monuments. The company motto is "Ambiance Élégance Raffinement".

6.4.2 Innovation drivers

Company C have recently implemented major technological products to automate operations, augment services and provide different options to customers. Smart TV have been recently acquired and installed in many different hotels belonging to C. The driver has been augmenting service offered to customer, however, the dynamics depicted through interview does not depict a clear decision making funnel for technological adoption. Company C declares that Smart TVs are not used by its customers, who prefer to use their own gadgets, as reported by Company C COO.

> *TV system for example with all the nice features that we recently implemented, they are not interesting, customer decide what they want to see they already have their gadgets and they just want to connect their things to the big screen. and all the nice modern systems they do not want them and we have spent money for nothing.*

Technological innovation and especially automation, for C is seen as relevant for Back Office activities. C is convinced that the main benefits and what drives their decision to adopt technology are from the internal perspective of streamlined operations, less tasks for employees and cost efficiency. Innovations should not be only a matter of amusing guests, but also and especially a tool for getting the most productivity out of people. In this sense, recently company C has eliminated the reception in one of their hotels implementing automated on-line check-ins. In this way, company C is saving labor costs and reducing the amount of work of staff. However, the personnel has not been removed completely in order not to remove the human touch. Instead, the automation of Check-ins have allowed Company C to focus more on delivering added customer service value to guests. A person now walks around the lobby helping out clients and welcoming them. The ultimate goal was to automate operations and use people for real customer service. The investment to automate check-ins, including the new doorlocks reached 100.000 Eur. Part of the investment is in the form of recurrent licensing fee due to the need of cloud service subscription.
Company C has recently removed breakfast from one hotel and has replaced the restaurant and kitchen with an automatic face recognition-enabled kiosk. Driver also here has been cost reduction and personalization. This system allow company C to be really customer oriented, while cutting enormously costs, as emerged from an interview with Company C COO.

> *for exmaple if we know that next week a group of chinese are coming, we refurnish the shop with chinese-like products. Thre's also the linkage to people and products purchased, what kind of people buy which product? so we can forecast and plan.*

Overall, we see that drivers of adoption fro Company C are more directed towards back office. On the other hand, in some cases technology has been adopted to obtain service augmentation for customers. This reflects the sampling characteristic choice for company C.

6.4.3 Room service

Company C offers room service in each one of their hotels except from the one utilizing the automated kiosk. RS is seen as a must-have service needed to maintain the rating. In 4 or 5 stars rating hotels RS needs to be in place, despite company C reports a very low volume of room service. According to C, the reason for the low usage of Room service is twofold. First, target customers prefer to eat outside of the hotel and do not even make significant use of the hotel restaurant. Second, C tries to discourage use of room service since it is a high cost low margin service for the company. Orders are received through phone, but C has started investigating mobile or TV based methods to collect orders in order to avoid misunderstanding and collect better and personalized data. Due to the limited number of rooms, on average below 200, C does not employ personnel dedicated entirely to bring dishes from kitchen to guest rooms. Desk personnel or kitchen staff have to leave their position and travel to guest rooms. This is seen as a matter of discomfort from company C since it is a time consuming activity that can sometime generate lack of adequate service: the desk position is left unoccupied for minutes. C reports an increased demand of food orders from external services, restaurants and bars. The orders received from external parties are not brought to guest rooms but the guest has to come downstairs and collect them. The whole process is not convenient and Company C reports to be frustrated with this phenomena. It generates rubbish, misunderstandings and loss of potential revenues for their restaurant. Company C declare to be aware of the existance of delivery robot and thinks they could be a useful tool to cut costs and allow C to offer room service in a more convenient and profitable way.

6.4.4 Factor analysis

Company C						
Factors	Present	Strongly Hampering adoption	Hampering adoption	Neutral	Fostering adoption	Strongly fostering adoption
Labor Shortage	■			X		
Management change	■			X		
Unprofessionality	■		X			
Ownership structure	■				X	
Complexity perception						
Inherent uncertainty	■		X			
Location						
Innovation Propensity	■				X	
Brand image	■			X		
Target customer	■			X		
Initial Investment	■	X				
Switching costs	■	X				

Figure 6.4.1: *Factor analysis for Company C*

Company C suffers from the labor shortage problem typical of hospitality industry. Most of all this is due to the kind of job contracts utilized. C reports that lack of people willing to work on the kind of hourly shifts that are required for kitchen or desk personnel. Moreover, the management of Company C is about to undergo a generational change typical of family owned businesses. This factor is typically present in the segment of whom C is representative in our sample. Being a family owned business, a certain amount of unprofessionality have also emerged. two out of three people in the management board does not have a formal education in hospitality or technology.

The influence of this factor is evident in one adoption decision of smart TVs which has been done without an adequate analysis of the requirement of the target guests. Ownership structure in this case seem to be favorable to adoption, since it is centralized and benefits of autonomy in purchasing decisions. Despite being a family owned traditional type of business, Company C demonstrated a high propensity to innovate and to introduce new technologies.

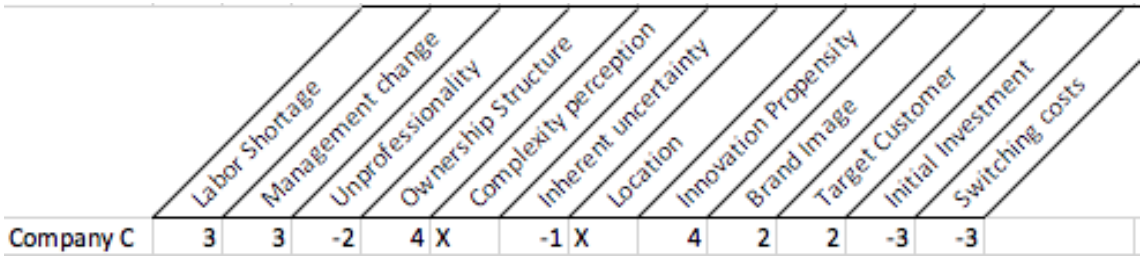


Figure 6.4.2: *Ranked Factor analysis for Company C*

The most important factors in place for Company C are most likely related to finance. Company C does not have a high investment budget and it is limited in the adoption choices by vendors business models. As mentioned by the management:

> *Leasing is better because it is easier to switch to a new technology without an investment to do. no loss of investment also. it's also very interesting because is on a fee base, so if they decide to increase pricing we can discuss with them , they know we are free to go with someone else.*

It rarely happens for Company C to invest in something without having the chance to try it before. A leasing model give the opportunity to try out something for a longer period. In addition, it gives Company C the opportunity to adopt technology on a wider scale in different hotels, something that could not be possible with a significant initial investment.

6.5 Company D

Company D is a single independent hotel situated in Makkah, Saudi Arabia. D is representative for the high-end luxury hotels with high number of rooms. The arab world is worldwide renowned and recognized for the highest Hijazi hospitality standards and ultra luxurious facilities and services. Company D has a five star superior rating and is known as being one of the most attractive hotels of the arab world. D, with a total of 1743 rooms ranks in the top 100 hotels worldwide with respect to size, and employs more than 900 people in total. D has a total of four restaurants and lounges that can accommodate up to 3500 guests. 26 elevators are displaced inside of Company D facilities. Company D offers a relevant variety of exclusive services to customers such as private limousines, loundry, spa treatments, ethnical cuisine and so on.

6.5.1 Positioning, Strategy and Target customers

D strategy is to expand and reach a total of 7000 rooms all in a unique building by the end of 2024. D relies significantly on Word of Mouth as a source of customer attraction and on its renowned brand in the area. Moreover, Company D benefits from the best location possible in Makkah, being only few meters away from the Holy Makkah. This allowed Company D to become the central hotel in the city and point of reference from all the wealthy pilgrims reaching Mekkah on an annual basis for religious ceremonies. This determines a certain level of seasonality in D occupancy rate which reaches its peak during the time of Makkah pilgrimage. On the other hand, according to management team, hotel reaches a 50% or higher occupancy rate during the whole year.

Company D targets customer of high social status and wealth. More frequently, D customers are quite old people on their 50s or 60s, definitely not technology savvy and used to the highest hospitality standards. D Guests demand for an exceptional level of service in every touch-point with the staff. Majority of customers visiting Hotel D come from the arab world: mostly from neighbor countries of Syria, United Emirates and Lebanon. A relevant and peculiar characteristic of D is that Usually guests come in large groups of 50 to hundreds of people, this generates particular dynamics in the booking and check in pipelines.

6.5.2 Innovation drivers

Company D has recently implemented a new software package to deal with organic group reservations. Organic means that these reservations are not mediated by the widely diffused on-line booking engines such as booking.com or Expedia.com. Majority of customers of D book directly contacting the hotel through phone or via email. This generates a significant amount of traffic in emails and phones of personnel that was source of problems. It usually happened that phone lines were occupied and customers could not finalize a reservation. This situations are particularly unpleasant for Hotel D and for hotels in general, since, most of the times, the customer just prefer to book somewhere else immediately rather than calling back. Th problem then often resulted in loss of potential customers, which, as mentioned, usually are large groups of people. So just for a simple busy phone line a couple of seconds Company D would lose 100 potential customers. In order to solve this problem, D adopted a new systems integrated with the PMS system that is able to distribute the organic traffic and solve the issue. The system, up to now, has not generated direct revenues from itself and it is not supposed to do so. The driver of adoption has been the avoided potential customer loss. We can categorize this as a back office driver.
Overall, company D cannot be defined as innovative. Nothing in the brand image as well as in the strategy reflects an innovation strategy. Company D looks mostly for innovation useful to streamline operations, increase productivity, cut labor costs, as mentioned by the management.

> *Our hotel is big, we have around 900 people in total as a staff in our hotel. That's why the owner is really looking for technology able to reduce that: it really impacts a lot on the costs. If you implement technology you might reduce a lot this figures.*

6.5.3 Room service

Company D offers room service 24/7 with a significant choice variety of foods and drinks. ten to fifteen people are employed with the exclusive task to bring dishes from kitchen to guest rooms. In a hotel of this size, on average a return trip for room service delivery takes 20 to 30 minutes. Room service is considered as a really labor intensive and costly service from company D which gains only low margins on it.
Demand for room service suffers significantly from seasonality and customer type. Peaks on demand reaches 200 orders per day and lows touch 10 orders per day. Company D IT manager reports:

> *it really depends on seasonality, weekends or this kind of factors, for example in sometimes of the year many people come from outside for specific events. sometimes we have around 100 / 200 deliveries in one day, but sometime maybe 10, it really depend on the kind of customers we have: the individual customers order a lot, groups don't.*

Room service is also seen as an important touch point between the customer and hotel staff. It is considered crucial from Hotel D to deliver high quality of service and a the moment in which the guest receives the delivery is especially curated by staff members.

6.5.4 Factor analysis

Company D	Present	Strongly Hampering adoption	Hampering adoption	Neutral	Fostering adoption	Strongly fostering adoption
Labor Shortage				X		
Management change				X		
Unprofessionality						
Ownership structure						
Complexity perception			X			
Inherent uncertainty		X				
Location						
Innovation Propensity				X		
Brand image			X			
Target customer		X				
Initial Investment						X
Switching costs						X

Figure 6.5.1: *Factor analysis for Company D*

Factor analysis for company D brings relevant takeaways for our research. First, both factors related to management and human resources are in place and have an high influence. D reportedly suffers from labor shortage. D requires highly trained staff due to the positioning in the superior luxury segment. Managerial generational change is also affecting company D. The whole operation management board have been recently replaced with a trained young management team. Ownership structure in this case does not seem to influence adoption. Ownership is simple and allow for the maximum grade of autonomy regarding purchasing decisions. Factors that have a significant negative influence are the perception of complexity and the inherent uncertainty. Company D has a misconception of the complexities necessary to introduce service robots. D attributes significant infrastructure change needed to the adoption of such technologies. Most of all D thinks a high level of training and advanced tech skills are necessary in order to successfully robotics. Moreover, inherent uncertainty linked with the target customer type is hampering introduction of service automations and robotics technologies in company D. The company thinks their customer type is not tech savvy at all and would not be capable of interacting with service robots and neither utilizing them. Finally, D wants to make use of every possible touch point with the customer to deliver its high level of services and its distinguished human touch. Company D things that delivering any kind of service through robots is not aligned with this fundamental idea.

	Labor Shortage	Management change	Unprofessionality	Ownership Structure	Complexity perception	Inherent uncertainty	Location	Innovation Propensity	Brand Image	Target Customer	Initial Investment	Switching costs
Company D	4	5	x	x	-2	-4	X	1	-1	-3	5	5

Figure 6.5.2: *Ranked Factor analysis for Company D*

Finally, Company D does not see initial investments or swithing costs as a problem. It is open to

experiment and invest significant capital on something that bears the promise to cut labor costs or attract new customers. Figure 6.5.2 summarizes the factor analysis scoring for Company D

6.6 Cross Case Analysis

Cross-case analysis is a widely adopted methodology to synthesize multiple case studies. It is an highly systematic method which includes a variety of devices such as tabular displays, graphs used to manage, summarize and display qualitative data. Evidence is collected from each primary studied and it is condensed into coded under broad thematic categories, including citations of primary evidence. Cross-case analysis is useful to underline commonalities and differences between the studies. Despite having the disadvantage of sometimes being an unnecessarily stifling process, cross-case analysis allows for inclusion of diverse evidence types and could be indeed used for theory building.[22]
In this section a cross-case analysis is performed with the aim to summarize and compare the evidence and findings collected in the singular cases.

6.6.1 Company profiles, positioning, target customer

Units of analysis for the cases has been strategically sampled based on their technology adoption drivers polarized into back and front office as described previously. Analysis of the cases definitely confirms the validity and assumptions made in the sampling strategy. Size of hotels was also used to sample facilities with more than 100 rooms. Table 6.6.1 summarizes findings. Companies taken as units of analysis significanlty differ from each other with respect to ownership structure, branding and positioning, strategy and target customer. Company A is positioned in a new emerging market niches of affordable luxury boutique hotels. Companies in this niches aggressively target the new generations of travelers, have, as A, an innovative design and experience driven approach and are extremely customer focused. Company A resulted also highly innovative. The whole business model is deeply intertwined with the use of technology and technology is adopted also in order to exclusively amuse the customer as a gimmick or to strengthen the brand image.

Table 6.6.1: *Cross case analysis results: Profile, positioning, strategy, target customers*

	Company A	**Company B**	**Company C**	**Company D**
N. Rooms	Av. 200	320	Av. 100	1743
Positioning	Aff. Luxury	Classic premium	Varied	Sup. Luxury
Branding	Boutique hotel highly innovative	Wordlwide renowned, innovative	Varied. Linked with local culture	Hijazi Hospitality
Strategy	Expansion (internationally)	New customer attraction / retargeting	Consolidation, cost efficiency	Expansion (locally)
Target customer	Millennials workers	Inventive class	Varied, unfocused	Large groups from Gulf countries

Company A strategy is focused on expansion with new hotels opening soon in US and Europe. A is highly standardized and centralized.
Company B instead is a classical, well renowned and established international chain positioned in the segment of "classic premium". The company is following a strategy of retargeting to attract new customers. Company B results being focused on trying to stay ahead of competition of new emerging companies in the segment of A. B aims at the same target customer which he calls "inventive class" which is considered as really important. B can be defined generally an innovation driven company. Innovation is not limited to technology but to processes and customization of services also. B has a big propensity and incentive to technologically innovate on both FO and BO.

Technologies which are able to bring significant improvement on both sides have high chances of being adopted.
Company C is instead representative for the most diffused type of hotel worldwide: the independent family owned chain. Company C has many different positioning and branding, none of them particularly strong. C has unexpectedly resulted being extremely innovative. It is the unique company utilizing sophisticated technologies such as face recognition and customization of available purchasing products. Drivers of adoption are mixed and unbalanced, depending on the single facility. A strategic focus is put on cost efficiency and brand consolidation.
Company D is totally different from A,B and C. D is positioned in the high end superior luxury with a brand linked to traditional Hijazi hospitality of arabic world. Target customers of company D is significantly different: large groups of wealthy people coming mostly from gulf countries. Company D is huge in size and focused on local expansion. D is not innovative and the technologies adopted have been driven mostly by the need to be operationally efficient and cut labor costs which are significant.
Overall, due to the strategic sampling, A,B,C,D show many differences and can be seen as an heterogeneous group representative of the different main market segments present in hospitality industry relevant for this research.

6.6.2 Hotel Room Service

Not all the companies involve offer hotel room service in their service offerings. Company A does not have a restaurant and does not offer room service. According to interviews with company A management, this choice have been driven by the branding a by the target customer. Target customer of company A is expected to prefer eating outside to discover the world, thus, A offers only basic food choice for a matter of convenience. Moreover, A prefers to encourage guests to use common areas, which are a distinctive element of A hotel designs, and interact socially instead of ordering food in the privacy of the room. On the other hand, Company A receives a relevant amount of requests for toiletries or small items to be shipped to guest rooms. Company A declared to have started a superficial investigation for adopting indoor delivery robots to accomplish these tasks. Table 6.6.2 summarizes findings related to room service for all the cases.

Table 6.6.2: *Cross case analysis hotel room service*

	Provided	**Daily Volume**	**Dedicated Employees**	**Dedicated kitchen**	**Profitability**
A	No				
B	Yes	20	2	no	Low
C	Yes	low	Desk/bar employees	no	Low
D	Yes	75	10/15	yes	Low

B,C and D all offer room service to customers. All the three companies agree on defining room service as a required service needed to maintain the rating and provide a decent level of customer care. B,C,D think that room service will never die: there will always be tired businessmen that after long journeys prefer to quickly dine in the privacy of their room for example. On the other hand, all three companies look at RS as a labor intensive, highly costly service that comes with a lot of hidden costs and discomforts for the hotels and little if no margins and advantages. Company B and D have dedicated employees for hotel room service who are the only task to bring the food from kitchen to guest room. D, due to the big size of the hotel has even 10 to 15 people in the delivery team, which represent a relevant source of costs. B,C,D volume of RS orders differs a lot from one or two deliveries to an average of 20 and even 75 daily. Regardless of average volume, all

companies agree that volume is highly dependent on seasonality and type of customer present in the hotel.
Finally, B,C,D noticed an increasing demand for food delivery from outside the hotel. This comes with many disadvantages for the hotel. First, it does not generate any revenue for the company, but, instead, it lowers potential revenues coming from own restaurants. Second, it generates a non negligible amount of extra rubbish and workload for housekeeping staff. And last but not least, could be cause of chaos in lobbies and misunderstandings between hotel staff, guests and food delivery personnel.

6.6.3 Factor Analysis

Factors influencing adoption of service robotics and automation where discussed in the interviews in the different cases. Not all the factors emerged as relevant during the interviews. As can be seen from figure 6.6.1, which summarizes relevant factors, location has never been mentioned neither has indirectly emerged as a potential influencing factor. Factors related to human resources such as labor shortage, management change and unprofessionality seem not to be present for company A. A, in fact, is a relatively new company with a completely different business and human resource model with respect not only to B,C and D, but generally with respect to the whole industry. So, company A is not influenced by these factors in decisions regarding adoption of new technologies. For all the other three companies instead these factors are present. The perception of complexity has note emerged in company A and C. Both companies does not look at this factor as relevant in their adoption decisions, moreover, they have an internal technology team that is technologically skilled and educated.

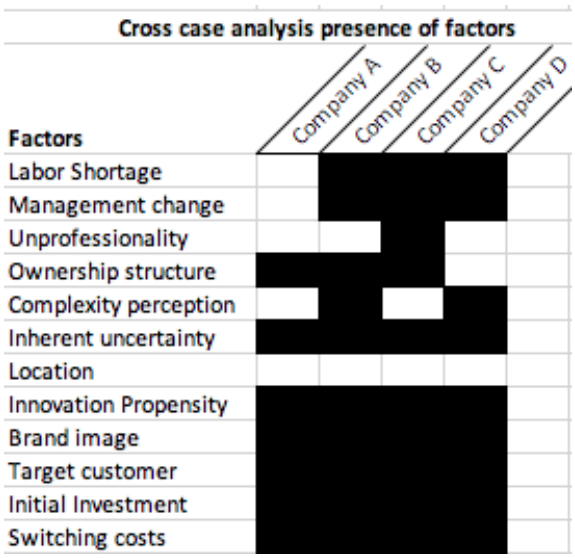


Figure 6.6.1: *presence of Factors cross case analysis*

It is useful to summarize and compare findings relative to the ranking of influencing factors for the different companies. We remind that a positive score indicates a factor that is fostering adoption of service robotics, while a negative score means that the factor is hampering introduction of such technology for each specific company. Generally, and unexpectedly, all the companies received a positive score on innovation propensity. A,B,C,D could be defined, to various extent, as innovative. D scores only 1 here since the introduction of technological innovations is driven by a necessity to follow and align with competitors in order to maintain a sufficient level of productivity and cost efficiency that allow D to remain attractive and competitive on the long run. A, B and C are all innovation driven companies. A above all, and B also link their brand to the concept of

being innovative and they declare the perception for the customer to be an innovative company is really important for them. A relevant finding is that A stated its propensity to adopt service robots exclusively to strengthen its brand image and innovative perception to its target customer. C, while adopting advanced automation technologies already in some hotels belonging to the company, does not link brand image to innovativeness and the brand is not influencing significantly the adoption of robotics technologies. A completely different result has emerged with respect to company D, whose brand is far away from innovativeness and technology and closer to human touch and traditional luxurious hospitality. This factor could instead hamper the introduction of service robots. Target customer of A and B is really similar and defined as the young, tech savvy and inventive traveler. Such a customer profile is definitely aligned with technology adoption and thus have a high positive score for A and B, oppositely to D, whose target customer type can even be defined as technology averse.

	Labor Shortage	Management change	Unprofessionality	Ownership Structure	Complexity perception	Inherent uncertainty	Location	Innovation Propensity	Brand Image	Target Customer	Initial Investment	Switching costs	Total
Company A	X	X	X	5	X	-1	X	5	5	5	3	3	25
Company B	5	3	X	1	-1	-1	X	3	4	5	2	2	23
Company C	3	3	-2	4	X	-1	X	4	2	2	-3	-3	10
Company D	4	5	x	x	-2	-4	X	1	-1	-3	5	5	10

Figure 6.6.2: *Ranking of Factors cross case analysis*

Great importance have been reserved in the interviews to financial factors such as initial investment and switching costs. In purchasing decisions, especially with respect to new cutting edge technologies such as robotics, financial factors usually play a significant role. Generally speaking, the weight and role of these factors differ significantly among the four companies. Company A, B and C look at initial investment and switching costs as limiting factors in their propensity to innovate. A and B however, have a decent liquidity that allow them to make substantial investment to adopt new technologies. On the other hand, all companies agree that initial invetments and switching costs are always to be avoided and prefer in any case to adopt technologies on a leasing model that allow them to minimize initial costs and most of all provide a way to try out the new product and service and be able to move to another one in case of failure without substantial losses. C, however, openly declared that this is the only model that allow them to do these kind of investments due to limited budget. Company D, instead, being positioned in the high end luxury, has higher margins that allow it to invest heavily in new technologies.

7. Discussion & Conclusions

This final chapter provides a summarizing overview of the research results and structures findings in order to answer research questions and ultimately solve the research problem. The discussion of findings will lead to the generation of a set of recommendations for Tactile Robots to design a viable business model. Practical and theoretical contribution of the research will be presented as well. Finally, after having extrapolated the conclusions, limitations will be underlined together with directions for future research.

7.1 Discussion

If we look at the first findings of our research, it is remarkable to note the fundamental difference in drivers for adoption of service robotics in hospitality with respect to industrial robots. At the beginning of the research we stressed the customer facing and service oriented nature of the hospitality business, and we already expected that some of the traction for the adoption of robotics technologies would have come from this side. Social or humanoid robots are one clear example of this. On the other hand, exactly for this deeply human nature of hospitality, it was not obvious to find out that the introduction of robotics is significantly driven by the need to amuse customer and provide him with gimmicks or new services. Robots can be blamed of removing what is considered one of the core values of hospitality industry: human touch. The main takeaway regarding adoption drivers can be summarized in their emerged polarization. Drivers can be ultimately categorized into back and front office, depending on the customer facing goal rather than a target of internal operational efficiency. This aspect has been used to frame a sampling strategy to select the companies to be studied, and further from case studies and cross case analysis has emerged how this polarization is crucial. In only one case, for company D, drivers linked to back office: cost efficiency and productivity were considered strong enough to determine adoption. However, exactly in this specific case, factors related to brand image and target customer have emerged which are hampering the introduction of robotics technologies. For Company A, B and C, back office adoption drivers were considered important to different extent, but the key insights is that for each of them, an added value to customer experience, both in terms of service augmentation or as a pure gimmick, is considered required in order to decide for adoption. This is extremely

useful to help framing value propositions for service robotics products to be adopted in hospitality.

Furthermore, similar considerations on adoption drivers are useful to start addressing the target customer Business model canvas building block. However, a discussion on factors is required to extrapolate meaningful conclusions. Factors have been extrapolated under the guidance of Technology, Organization and Environment (TOE)[57] framework and mapped along these three dimensions. Environmental factors such as Labor shortage and managerial change are playing a crucial role in determining adoption. Those factors emerged multiple times from preliminary research and the management of all four companies underlined their relevance. Besides, Company A innovative business model protects it from these factors and their influence is significantly mitigated. Moreover, it could be argued that some hotels are also trying to put the focal lens on this issues in order to justify the introduction of automation solution aimed at substituting human labor with softwares and machine, which could most likely lead to social debate with repercussions on brand integrity. We remark how this is just a speculative statement that has not been backed by proper research. Unsurprisingly, branding, as an organizational factor, has a great influence on adoption decision especially for companies with a strong brand identity, which target really aggressively a specific customer group. For company A emerged that the brand strengthening alone was a sufficient driver for adopting robots and alignment with the brand was the most important element for the company when evaluating service robotics solutions. If we look at cross-case analysis scoring, this played a dominant role in determining the high score of Company A. Target customer for hotels is also at the basis of the modulation of adoption intention and could be seen as a factor deeply linked with brand image. The same considerations thus apply here. We saw how hotels have started to address the new generations of millennials travelers and are trying to align their service offerings and image in order to conquer those customers. This trend was particularly evident for company A and B, and could be seen as a factor fostering significantly adoption of robotics solutions. These customer are tech savvy and are used to pervasive technology.

Overall, innovation propensity was really high, especially for company A and B who also linked innovativeness and inventiveness deeply with their brand image. However what was unexpected was to find out the high level of innovation propensity for company C. Company C was sampled due to its representativeness of the most diffused kind of hotel with respect to size, positioning and ownership structure. C was not expected to be such an innovative company: from interviews emerged that C adopted the most technologically advanced automation solutions compared to all the four companies examined. So, also the perception of complexity did not turn out to be a powerful factor. Management of Company C did not show to overestimate complexity of robotics and automation solutions, although, digging deep in the interview, it emerged that Company C significantly overestimated costs related to robotics solution that they had been exposed to in trade shows or fairs. For Company D, being the least innovative company of the four, complexity perception proved to be affecting adoption. Management overestimated both the costs and the integration issues for robotics to be adopted. The size of company C was significantly smaller in comparison to the others and penetration in its market segment is difficult due to fragmentation. Fragmentation is a concept that emerged multiple times regarding hotels ownership structure. Company C was not fragmented in ownership, a family owned business running 15 hotels. However, for company C fragmentation is present in the management: each hotel is managed independently, and most of all in its segment of reference. This is an element which is significantly hampering adoption of robotics. In this sense, it was interesting to find out that company B, despite being part of one of the most well renowned and diffused hotel chains worldwide, has a significant degree of autonomy with respect to purchasing decisions for new technologies. Only a few solutions were adopted as "brand standard" from the Franchisor company and introduced to each Franchisee. The wide majority of adoption choices are done on an individual basis. This reflects in almost the same penetration and diffusion issues as for company C. Location has never emerged from the cases as

being a relevant influencing factor. This is certainly due to the general aim of the cases in which the specific type or application of service robot was not specified a priori. However, for the specific case of Tactile Robots' indoor delivery robot for hotel room service, location could play a role. Generally speaking we saw how company B,C and D, which offer room service, tend to discourage the usage of this service. However, for resorts and hotels far from cities, so with limited choice with respect to food and beverage, room service could be incentivized instead, and thus location could be considered relevant and could play a role in influencing adoption for this specific robot. Moving the focus towards room service, then, all companies analyzed consider it a labor intensive and costly service to offer. Company A even decided not to introduce it. Unexpectedly, though, despite not offering room service, Company A was the only one that investigated adoption of indoor delivery robots. A was driven by the need to fulfill customers requests of other items such as toiletries and gadgets. However, The combination of high volume of room service, target customer, brand and the adoption drivers make company B the most suitable launching target customer specifically for Tactile Robots. On the other hand, Company B did not score the highest in the factor analysis and, generally, company A could be indicated as having the highest propensity to adopt service robotics solutions. Finally, financial factors are of great importance in influencing adoption intention of robotics in hospitality. Hospitality turned out to be a business characterized by low liquidity and low ability to invest high sums, especially with respect to new technologies. All companies underlined this, to different extent, as being a factor of major importance in determining their technology adoption decisions. What all of them look for, and this is especially true for Company C, are solutions that allow them to minimize the initial investment, even if this privilege comes with a higher total cost. Initial investment is not the only issue here. Hoteliers have also to face with switching costs when a technology becomes obsolete. Company C underlined how switching costs, linked to inherent uncertainty of cutting edge technologies usually discourage the management to adopt new technologies. Inherent uncertainty is considered significantly high when it comes to radically new technologies such as service robotics. These aspects summarize useful insights that can be translated into recommendation on the Revenue model building block of The Business Model canvas, which is the last one considered in this research.

7.2 Conclusions

First, it is useful to report here the research problems for the sake of clarity. As stated the introduction, the first problem identified was:

- **There's a lack of clarity regarding what is driving adoption of service automation and robotics in hospitality industry.** Furthermore, **nothing, or only a few is known about which are the technological, organizational or environmental elements influencing adoption of service robots in hospitality**.

After having delineated the research problems, crafted the research framework and built the research questions, the actual research started from a review on theories on adoption of technological innovations and literature on business models. Technology, Organization and Environment (TOE) framework and Business Model Canvas (BMC) have been used to build a conceptual model that guided our research, which is reported in fig 7.2.1 for the sake of clarity.

TOE framework identifies the three aspects of technological, environmental and organizational contexts as influential to the process of adoption of a new technology. The first steps of our empirical research: focus group and interviews, have been steered in order to investigate the factors influencing adoption of service robot in hospitality within the three specific contexts of technology, organization and environment. Table 7.2.1 summarizes the emerged factors mapping them along the TOE framework dimensions.

We can conclude that adoption drivers and influencing factors emerged from research are the ones summarized in table 7.2.2. Table 7.2.2 represent the solution to the first research problem.

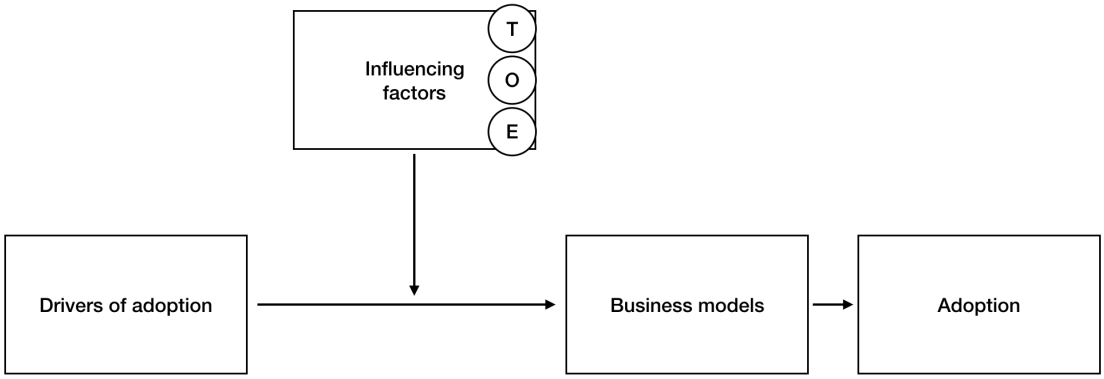


Figure 7.2.1: *Sampling of units of analysis according to polarized adoption drivers*

Table 7.2.1: *Factors categorized according to TOE*

TOE Framework	Factors
Environment	- labor shortage - Management change
Organization	- Brand image - Target customer - Innovation propensity - Complexity perception - Location - Initial Investment - Switching costs
Technology	- Inherent uncertainty

Table 7.2.2: *Summarizing list of drivers and factors identified*

Adoption Drivers	Factors
- Cost efficiency (Productivity) - Accessibility - Service augmentation - Sustainability - Health and safety improvement - Labor turnover reduction - Strategic differentiation	- Labor shortage - Management change - Brand Image - Target customer - Innovation propensity - Complexity perception - Location - Initial investment - Switching cost - Inherent uncertainty

Next, the conceptual model, together with results of initial empirical research, have been used to structure four case studies in order to solve the second research problem:

- **Despite a first preliminary effort of market and customer validation, Tactile Robots still lacks a complete understanding of the requirements of the users, customers and of the conditions under which they are willing to be delivered value by the company, together with a lack of clarity regarding the conditions under which Tactile Robots itself is able to deliver value to stakeholders and to capture value from them.**

From the conceptual model emerges also the main scientific contribution of the research: taking into account contextual and environmental factors of adoption of new technologies in the business model design for new high tech ventures in order to overcome the limitations on current Business model ontologies, such as the BMC. These limitations ca be summarized in the static nature of BMC and in its narrow focus on internal aspects of the firm and its value chain.

Based on findings from the case studies, it has been possible to extrapolate a set of clear conclusions which result in recommendations for designing a viable business model for Tactile Robots. First, we remind how we circumscribed our focus on three out of nine building blocks of the Business Model Canvas: Value propositions, customer segments and revenue model. Regarding value proposition, it has emerged how the increased productivity and cost efficiency alone are not strong enough driver for determining a positive decision to adopt service robotics technologies. This translates into the first recommendations for value proposition design:

Value Proposition

In order to build an effective value proposition, the focus should be put on hotel customers. Hospitality business in extremely customer and service centric. Tactile Robots aims to introduce a service robot which will have a certain degree of contact with customers. For this reason, the focus of the value proposition should not be limited to cost efficiency and enhanced productivity, but should be put also, and predominantly, on the benefits and values conveyed to the guest in terms of privacy in receiving the order for example. It should also be stressed the added value to the brand and image of the adopting firm.

Research showed how the hospitality industry is extremely fragmented in terms of ownership structures, positioning, branding and so on. Case studies were conducted in four companies representative of the four relevant segments identified as being the most relevant for service robotics adoption. Results showed how company A and B are the most likely to adopt service robots thus representing the preferred customer segments.

Customer Segments

Most suitable customer segments for Tactile Robots are two. The first is composed by innovative affordable luxury boutique hotel chains which demonstrated a high propensity to innovate and an aggressive targeting of young tech savvy generations. On one hand, these target customer looks at service robot as being cool and different gimmicks to entertain customers and strengthen brand image. On the other hand, companies on these segment rarely have room service in place and the back office benefit of adopting an indoor delivery robot are minimal. The second target customer is composed by established and worldwide renowned hotel chains. In addition to representing a significant portion of the hotel industry, Companies within this customer segment show a high propensity to adopt TR solution both to solve the labor cost issue and to offer an innovative brand aligned experience to the customer. For these reason, this segment is the most suitable for Tactile Robots market entry.

Revenue Model

Regardless of the value proposition or customer segment identified, finance factors relative to initial investments and switching costs resulted being significantly relevant. All the companies

openly stated the need to look at technologies with low installation costs and whose business model involves a certain degree of flexibility in trying the solution before ultimately adopting it. For these reasons, the preferred revenue model suggested to Tactile Robots is a licensing model with recurrent annual or monthly fee. On one hand, this will weight more on the capital intensity of Tactile Robot's business. On the other, a licensing fee will allow TR to have a wider market entry and penetration.
The aforementioned set of conclusions solve the research problems and reach the research goal, which was: **To make recommendations to Tactile Robots about the design of a viable business model for the company by providing an overview of drivers of adoption for service robotics in hospitality, factors influencing those drivers, and customers opinions regarding Tactile Robots' technology-market fit**

7.3 Theoretical and practical contribution

This research aims to fill the theoretical and practical research gap on service robotics potential for the hospitality industry, and to contribute to business model design literature for high tech startups. Several theoretical and practical contributions can be underlined.
First, this research provides a comprehensive and complete review of examples of adoption of service robotics technologies in hospitality industry. Almost no or only superficial research has been carried out on this topic and several authors underlined the need to fill such a research gap [36] [44]. Furthermore, this research gives an understanding of drivers of adoption for robotics in hospitality. The study also provides a contribution to the business literature on factors influencing adoption of new technologies in organizational settings. In this sense, this research contributes to theory of adoption and diffusion of innovations by providing an instantiation of the TOE framework adapted and applied to the specific case of service robots technologies in the hospitality industry.
The most relevant scientific contribution of this research lies in the use of theories of adoption such as the TOE framework as a complementary tool to Business Model Canvas in business model design for new high-tech ventures. Generally speaking, BMC and BM design methodologies limit their focus on customers and actors directly present in the new firm's value chain. Moreover, they lack an understanding of the context and do not take into accounts the dynamism of the environment and the factors external to the firm that play a role in the adoption of the new proposed technology or product. We showed how the general identification of drivers of adoption and influencing factors carried out initially in this study, involving different stakeholders external to the firm's direct value chain, has resulted in valuable knowledge useful to structure the case studies and thus the first contacts with potential customers. **In this sense, context and environment have been extensively taken into account, counterbalancing the staticity and firm-centricity of the Business Model Canvas as a business design framework.** This can be seen as a novel approach to business modeling that can result in major advantages for business model design of radically new businesses, targeting new customers or providing radically innovative products.
In addition, This study contributes to business literature on the hospitality industry by identifying and describing business models and business model design for emerging technological startups addressing this market. Results and recommendation extrapolated to guide the business model design, while having been instantiated in the Tactile Robots case, are to a certain extent generalizable to other startups operating in the field or also can be used by corporates who want to launch robotic based products or services targeting hospitality industry. The structuring of the cases, in fact, have been done based on a conceptual model which did not take into account the peculiar case of Tactile Robots, but, instead, it was performed by assessing generally the desirability of service robotics technologies in hospitality, through the individuation of adoption drivers and influencing factors.
To conclude, the study provides the practical contribution of giving recommendations to startups willing to introduce product and services based on robotics technologies in hospitality industry.

Drivers of adoption identified could be also used by companies that are about to introduce technologies of different nature in hotels. Policy makers can also use the identified factors in order to develop and review the policy frameworks so that they can facilitate market entry for service robotics startups in hospitality, and also stimulate innovative activities in the "old fashioned" hospitality industry.

7.4 Limitations and future research

Different limitations can be identified for this study. The first major limitation of this research concerns the dynamic and rapidly evolving nature of robotics technologies and its applications. One of the first research efforts had been to carefully investigate the current examples of use cases and adoption of service robots in hospitality industry. These applications are rapidly evolving; we saw how in last months new robotics solutions are emerging and are being introduced in hotels and restaurants. Evidence forces us to consider that the pace in which robotics are being introduced and are diffusing inside commercial spaces and mostly in hospitality is very likely to accelerate, meaning that, at the time this research will be published, it could be already somehow outdated from this point of view.
Furthermore, this research has been exploratory in nature and thus used a small sample size. Using a small sample size, while is common practice in exploratory studies, make the study less generalizable. Initial empirical research was carried out gathering opinions of a small group of experts, and the case studies were limited to four companies strategically sampled in order for them to be representative of a certain group of segment of hospitality industry. Of course this does not assure that the same findings could be extended to other similar companies operating in their segment. Finally, insights emerged from the research and used to structure recommendations for business model design for Tactile Robots do not guarantee that the implementation of the same recommendations in another service robots company can be successful. We also remind how, environmental factors related to policies, regulations and other country specific issues have been left out. This, on one hand allowed us as researchers to focus on the core elements of technology customers and market useful to enhance the theoretical generalizability, but on the other limited the practical generalizability. The fact that this study is exploratory also results in the inability to make definitive conclusions about this topic.
Moreover, in this study we utilized mostly semi and unstructured interviews as data-collection method. This approach was chosen since it resulted being very much suitable with the research objective, but comes with many limitations, such as the lack of rigorous standards. The analysis carried out in the case studies and cross case analysis, such as the factor analysis, has been carried out by the researcher. While based on sound empirical results extrapolated from interviews, a small degree of subjectivity in the results in not neglectable.
This study showed how research on service robots in hospitality industry is at its infancy. Little or no academic papers are available on the topic which mainly provide research agendas scratching the topic on the surface only. Based on the emerged research gap, we encourage research addressing the challenges that managers and owners have to face in introducing service robots in hotels. Moreover, research aimed at investigating guest acceptance of service robots in hospitality is highly needed. This study is limited to the buyer of service robots but does not assess the desirability of such technologies for the ultimate users of those products: hotel guests. This is of major importance for understanding how robotics will or won't be able to take over hospitality industry.
Finally, The contribution of this research to business model design encourages researchers to further investigate how TOE and other frameworks can be used to guide the process of designing new business models. The incorporation of such theoretical tools has the goal to take into account the firm's context and environmental factors before starting to aggressively target potential customers, overcoming the major limitations of widely used business models ontologies.

II

Appendix

TactileRobots
DESIGNED TO SERVE HUMANS

8. Annexes

Annex 1: Topics to be covered in interviews

Hotel Managers and Executives

Background

- Can you tell me a bit about the company?
- Who are the owners? Management structure? How many employees?
- The formal position of the interviewee
- Which trends does you believe are now impacting the business (with concrete examples)? How did the business change in last years? How does the company deal with changes?
- Does the company have a strategy or long-term vision?

Innovative activities and purchasing decisions

- How does the company deal with innovation?
- What was the last time you engaged in an innovative activity or the last time you established an innovative product or service? Which was this product/service? To solve which problem? Was it visible for the customer/intended for the customer? Did you develop the product/service alone/with partners, or did you buy it from a third party? Under which conditions/ terms? How much did you pay/invested for it?
- Can you talk me through the process? What happened? Who was involved? Did it solve any problem or provided tangible benefits? How was its effect assessed? How was the change managed?
- How are this kind of decisions taken within the company? Who is responsible for innovative projects? Who has the last word and/or purchasing power for new products or services?
- Do you allocate resources on a regular basis to perform innovative activities or test new products or services? How much? with what goal?

Differentiation strategies and marketing

- How much differentiation is important for you? What are you currently doing in concrete to differentiate? Talk me through last time you took concrete action to make your company different from customer's perspective... Was it a success? Why?
- Do you think that the reputation of being an innovative company is important for you? Does

it help in being competitive/attractive? Why? What was the last time you took action to be perceived as innovative? What did you do? Did it work?

- Which marketing channels do you use? Which are your target customers and How do you engage with them? What are you doing to attract new customers? Is it working?
- Are you making use of digital booking/review platforms, social media to reach your target? Why?

Hotel room service

- What do you think about hotel room service? Why do you offer it? Have you always offered it or did you established it recently? Is it profitable to you?
- How much hotel room service orders do you receive on average on a weekly/daily basis? Do you think you will continue to offer it in the future? Why/why not?
- How are you dealing at the moment with hotel room service? How are orders handled? Do you use any kind of digital aid/instrument to deal with it?
- Is part of the workforce dedicated entirely to Hotel room service? If not, how much does Hotel room service weight on workload of the staff? is that a demanding activity for your personnel?
- How much does it cost to you to be able to provide hotel room service?
- Do customers order food from delivery services/restaurants outside of the hotel? Is this allowed by you? Did anybody asked you explicitly to do so? If so, how often does it happen? Talk me through the last time it happened and how you dealt with that.
- Are you taking concrete action to offer/improve this kind of service to customers if it is requested? How?

Staff and employees

Background

- Role at the company
- Do you think the company is innovative? What was the last time the company introduced an innovation/change that affected your working routine or habits? Talk me through that and explain how were you involved and how did you and the company dealt with change. Was it a success? Why or why not?

Hotel Room Service

- What do you think about hotel room service? What is your experience with this service? How much hotel room service orders do you receive on average on a weekly/daily basis?
- How are you dealing at the moment with hotel room service? How are orders handled? Do you use any kind of digital aid/instrument to deal with it? Can you talk me through the last time you dealt with a hotel room service order?
- Is part of the workforce dedicated entirely to Hotel room service? If not, how much does Hotel room service weight on your workload? is that a demanding activity for your you and the personnel?
- What you would change about hotel room service?
- Have you ever received a request from a customer to order from restaurants/delivery services outside of the hotel? How did you deal with that? Talk about last time it happened. How many times has it happened?

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