



Vaasan yliopisto
UNIVERSITY OF VAASA

Sourav Mukharjee

**Enhancing Hospitality: The Economic and
Operational Benefits
of Robotic Cleaning Technology**

School of Technology and Innovations
Master's thesis in Industrial Management
Master's Programme in Industrial Systems Analytics (ISA)

Vaasa 2024

UNIVERSITY OF VAASA**School of Technology and Innovations**

Author:	Sourav Mukharjee		
Title of the thesis:	Enhancing Hospitality: The Economic and Operational Benefits of Robotic Cleaning Technology		
Degree:	Master of Science in Technology		
Discipline:	Industrial Systems Analytics (ISA)		
Supervisor:	Rayko Toshev		
Year:	2024	Pages:	79

ABSTRACT :

This thesis focuses on the use of automated cleaning solutions in the Original Sokos Hotel of the S-group hospitality industry and on the possible cost aspects and operations management implications. It evaluates the projected benefits to be accrued from investment in automation for human labor in cleaning jobs. From the break-even analysis, it is indicated that with a total investment of €20,000 on cleaning automation, the firm can be breakeven in a short period of time. A five-year net present value (NPV) also shows a positive prospect for the clean automation. Furthermore, according to this study, there is centrality in performance expectations throughout the organization, where employees will be able to devote more of their time to value-adding processes than otherwise, improving guest satisfaction. The study also assesses the sustainability implications of automation cleaning systems, especially on hygiene factors. In preparation for the integration to occur, it is expected the change is going to be well managed throughout the hotel since other facilities like staff training and organization-wide communication will also be made. This study reveals that there is a potential for hospitality organizations to get benefits from automation, as this may enhance the standard of service delivery and organizational performance as well as improve cost effectiveness, as one of the benefits of the study.

This thesis gives significant implications to hospitality organizations that are interested in adopting robotic cleaning services, highlighting the advantages of expense reduction and quality enhancement. The findings assert the use of automation technologies throughout the industry, pointing at the potential for future development of new efficiencies in other functional areas, including maintenance. Finally, this study clearly shows that hospitality industries can greatly benefit from automation, using it to increase the levels of service quality and efficiency while at the same time being a cost-efficient solution.

KEYWORDS: Industry Automation, Operational Efficiency, Break-even Analysis, NPV, Sustainability and Environmental Impact, Change Management in Automation.

Contents

1	Introduction	7
1.1	Background	9
1.2	Problem Statement and Research Questions	12
1.3	Objective of the Research	13
1.4	Limitation and Significance of the Research	14
1.5	Research Contribution	15
1.6	Thesis Structure	16
2	Literature Review	18
2.1	Overview of Hotel Cleaning	19
2.1.1	Overview of Manual Cleaning	19
2.1.2	Overview of Uses of Machines in Cleaning	21
2.1.3	Growing Trends of Robots in Cleaning	22
2.2	The Evaluation of Automation in the Hospitality Industry	23
2.3	Shift Distribution and Work Plan	24
2.4	Salary and Effect	25
2.5	Maximizing Profit through Technology	26
2.6	Analysis Structure of the Research	27
3	Methodology	32
3.1	Cost Structure Analysis Framework	32
3.1.1	Fixed Cost	33
3.1.2	Variable Cost	33
3.1.3	Flexible Cost	34
3.1.4	Break-even and Net Present value	35
3.2	Scenario Analysis Framework	36
3.3	Interviews and Observations	37
3.3.1	Interview Design	37
3.3.2	Data Collection Process	38
3.3.3	Data Security Process	39

4	Result and Outcome	41
4.1	User Case	41
4.2	Fixed and Variable Costs Analysis	42
4.3	Flexiable Costs Analysis	43
4.4	Break-Even and Net Present Value (NPV) Analysis	43
4.5	Scenario Analysis	47
4.5.1	Full Automated with Technological Advancement	47
4.5.2	Semi Automation with Stable Labor	48
4.5.3	Manual Cleaning with Genral Machines	50
4.5.4	Comparison of Scenarios	51
4.5.5	Outcome of Scenario Analysis	53
4.5.6	Comparison of Chepest to Expensive automation Models	55
4.5.7	Explanation of Scenario	57
4.5.8	SWOT and PESTAL Analysis	59
4.6	Case Study	63
4.6.1	Selection of Automation System	63
4.6.2	Data Analysis and Economic Outcome	64
4.6.3	Transformation Timeline	65
5	Conclusion	67
5.1	Addressing the Problem Statement	67
5.2	Theoreticial Contribution	68
5.3	Practical Contribution	69
5.4	Future Work	70
	References	72
	Appendices	77
	Appendix 1. Data Collection for BEN and NPV	77

Figures

Figure 1. Manual Cleaning Process in Sokos Hotel	20
Figure 2. Manual Cleaning Machines	21
Figure 3. Shift Distribution in Sokos Hotel	24
Figure 4. Break Even Point	45
Figure 5. Technological Advancement vs Labor Cost	48
Figure 6. Manual Cleaning Scenario	51
Figure 7. Scenario Analysis Outcome	54
Figure 8. Market Price Comparision	57
Figure 9. SWOT Analysis	60
Figure 10. First Interview with Sokos Manager	77
Figure 11. First data collection from hotel	77
Figure 12. Budget Calculation Data Collection	78
Figure 13. Meeting with Done Robotics	78
Figure 14. Structure Analysis with Done Robotics	79

Tables

Table 1. Automation Initial Input	48
Table 2. Automation and Human Cleaning Comparision	49
Table 3. Labor Vs Automation Outcome	52
Table 4. Model Expense Comparison	56

Abbreviations

AI - Artificial Intelligence
 DSR - Design Science Research
 NPV - Net Present Value
 IoT - Internet of Things
 ROI - Return on Investment
 TVC - Total Variable Cost
 S-Group- Suomen Osuuskauppojen Keskuskunta

TFC - Total Fixed Cost

TC - Total Cost

APA - American Psychological Association

KPO - Keskusosuuskunta Pohjanmaa

1 Introduction

Royal Vaasa original by Sokos Hotel is the biggest commercial wing of the S- group in Finland. The way it provides services to the customers is only possible because of the cleanliness and shiny environment of this hotel. Meanwhile, this hotel is spending a lot of money and time in the cleaning process which is making a barrier to annual profit gain. Furthermore, this cleaning process could be accomplished by automating technology which could bring an economic boost to the S-group and can make a unique introduction of technology in the hospitality industry of Finland. Jasonos & McCormick (2017) explained that the application of technologies and automation of processes has been growing at a relatively fast pace in industries globally, and this has also applied to the hospitality industry. In the current digital period, advanced technologies such as artificial intelligence (AI), automation, and data analytics have greatly transformed the conventional approaches to business, primarily in the provision of services (Fatih, 2019). In addition, implementing these technologies into the day-to-day operation presents new prospects for businesses including hotels to work more efficiently, and making customers happier. This transformation is remarkable to some extent in the use of robotic systems in cleaning services.

Large-scale hotel operation involves keeping the facilities very clean, but this must be done in the most efficient way possible when it comes to the costs of staffing, materials used and guests' satisfaction (Moreno et al., 2024). In the past, most cleaning activities in hotels have employed manual methods through human effort, which though essential is prone to difficulties in computation, productivity, and quality (Jones, 2007). Vacuuming of carpets, cleaning and disinfecting floor, corridors, elevators and guestrooms are exhaustive and time-consuming tasks that involve many efforts hence involve many resources which cost a lot, and their costs vary with the season or the number of guests. However, the use of human workers threatens the frequency of human errors, inconsistencies, and fatigue which reduces the quality-of-service delivery (Nikolskaya et al., 2020). This research will analysis the economic and operational impact of introducing automation in the cleaning system for hospitality industry in Finland. It will find out the efficient

utilization of using automation instead of manual labor-intensive process. The research outcome will be the benefits of using automation because of surprising increases in labor costs and demand for sustainability. This study focuses on the analysis of break-even and NPV (Net present value) in the long-term financial gain for the KPO based Original Sokos Hotel, a part of S-Group in Finland. The conception and application of robotic cleaning systems propose a good solution to these challenges, as consistent cleaning requires time, energy, and hard work, automating common tasks will help cut down on the number of employees needed which in turn will serve to save hotels a lot of money without compromising on cleanliness. Robotic systems work 24/7, and do not require rest unlike human beings therefore serving the hotel and its guest with professionalism in cleaning services delivery. Furthermore, these systems can be interfaced or linked with currently used hotel management software so that control of cleaning schedules, equipment used, and maintenance requirements can also be more effectively coordinated. The financial and operation parameters of utilizing robotic cleaning systems in the context of the increased business profitability of the Original Sokos Hotel in Vaasa, Finland is a topic of the presented thesis. The objectives of the study are as follows: to assess the economic rationality of automating the cleaning process using robotic cleaners, to determine the payback period and Net Present Value (NPV) of the investment, and to consider the patterns revealed in the context of further improvement of operational performance, satisfaction of the guests, and environment conservation.

As the tourism sector becomes one of the relentless priority sectors of the state (Waris et al., 2024) the hotel industry as one of the significant sectors has a great role in creating a positive image of the service quality as well as the nation. To this end, a hotel like the Original Sokos Hotel is strategically important in offering quality hotel and related services to both domestic and international visitors. However, like other leading hotels in the market all over the world, Sokos experiences more pressure in the sense that it must work hard to control costs and at the same time provide quality and satisfying cleanliness services. This is more so in the current world with the COVID-19 pandemic making it compulsory for establishments to increase their cleaning standards and hygiene

measures to meet guests' expectations (Ostrowska & Pawlikowska, 2022). Remarkably, the application of robotic solutions in cleaning is not entirely new but some notable hotel corporations and commercial cleaning companies have to some extent incorporated robotic systems into work (Bagadiya & Kathiriya, 2024).

This research will help to fill this gap by offering a comprehensive analysis of the cost and benefit attributes of robotic cleaning systems. The following calculations of financial ratios will provide long-term analysis on the financial viability of employing robotic cleaning system (Skachkov, 2024). Furthermore, the outcomes of the change on the operational aspects such as the efficiency of cleaning as well as the usage of resources and productivity of staff will also be examined in the research. With this framework the study will offer hotel managers and decision-makers qualitative information about automation and technology that would prove helpful for future investment. Thus, the purpose of this research is to show how the implementation of robotic cleaning systems can contribute to the efficiency of the overall hotel functioning and the improvement of the financial and qualitative indicators. As the concept of hospitality opens to new technologies and customers' needs and expectations the result of this study will contribute to the development of the understanding of how automation impacts on the future of hospitality services.

1.1 Background

The cleaning industry is today practically fully manned, and as far as development is concerned, the cost of human capital is equally high like other equipment and material (Kosta, 2024). Although it is in the process of technological evolution, where mechanized cleaning, which replaces the manual cleaning process to save time and costs, is emerging. On the other hand, the assessment of automation will develop an interesting proposal for the large and small scale of hotels in terms of time and efficiency improvement (Lee, 2024).

The present study focuses on one of the most significant and manual branches of the international tourism sector. In the last few decades, hotels have incorporated a number of different technologies into the ways they run their business and serve customers (Buhalis, 1998). The future is already knocking at the doors of hotel management methodology through adopting Robotic Systems that bring out the new horizon in managing daily tasks (Ivanov & Webster, 2024), specially housekeeping and cleaning Section. The ways through which the hotel industry has faced some demands for the automation of solutions include the following factors. First, the increase in the cost of labor has forced hotels to look for methods with which to complete the tasks common to most lodging businesses in a more efficient manner (Khanh & Phan, 2024). Again, one of the largest expenses categories in most hotel operations is labour and this is probably more pronounced in countries such as Finland. Secondly, the outbreak of the COVID-19 pandemic has brought issues of sanitation and hygiene in the hospitality industry into the lime light (Yang et al., 2024). Customers want greater cleanliness, especially with more people interacting in common areas such as reception, restaurant and lifts (Pillai et al., 2021). Satisfying these expectations has now been an important goal of many hotel managers, who have to guarantee not only effective cleaning but also the visibility of the process to the guests.

Instead of increasing the pressure on the human operators in order to achieve these elevated expectations, robotic cleaning systems provide a solution. Third, with the adoption of artificial intelligence and robotic technologies, it has become possible to create completely self-contained systems that can then be relied on to implement substantive tasks with very little interference from people (Musekiwa et al., 2024). Robotic cleaners have a capability to sense space, detect where cleanings are needed and adapt to the current environment and situation. Such systems can be utilized to run whole day offering consistent data to complement human workers who can then handle the jobs that require advanced interaction like clients or maintenance. Hospitality sector and particularly hotel industry is a major industry in the chain of revenue generation for the Finnish economy both locally and internationally (Mitra, 2023). For instance, namely

such hotels as the Original Sokos Hotel are the key players in the countries' tourism supply chain since they offer their services to the tourists and also actively participate in the distribution of the revenues received. This seems to be the case as more players continue to join the hospitality industry making accommodations more competitive than ever before with cuts on expenses while continuing to deliver top notch service. One example of this is Robotic Cleaning Systems, which means that hotels can essentially save on labor costs, optimise operational processes, and simultaneously bringing potential added values to the guests (Sharma et al., 2024). This study aims to investigate opportunities that automatic cleaning systems present to the Sokos Hotel through understanding how automation fulfills the threats of the hotel business and adds to sustainable development.

In the hospitality industry, operational efficiency is becoming a major issue as strategies for controlling the rise in labor costs (Liu et al., 2024). Such high costs, especially in areas such as personnel, which entails massively in cleaning processes, is rather costly in the current rising market competition. Therefore, the outbreak of the pandemic increased the requirements of stringent measures on hygiene that subsequently increased expense on operations. Although manual cleaning is still implemented in many hotels, automation in general, and robotic cleaning systems, in particular, is an effective solution for addressing new problems in the field. Shukla et al. (2024) explained that using robots in cleaning operations is cost-effective as unlike employees, such systems can always operate, do not require breaks or vacations, and their precision in interfacing with cleaning exercises minimizes errors. However, there remains research about how robotic cleaning systems bring economic benefit to mid-sized hotels especially from the Finnish perspective. Most of the past research works have targeted only on largest chain hotels or other segments, therefore the future directions and sustainable profitability (Barbara et al., 2024), breakeven and cost-affordability of such systems for smaller hotels remain ambiguous.

1.2 Problem Statement and Research Questions

A wide range of autonomous robot types is available in the market at the moment, KPO (S-group) has no access to it. The daily labor cost of operation for this largest commercial institution is gradually increasing. This is why this company is far behind, the high number of people earning them a high cost in labor. Due to this, the whole process of deep cleaning should be automated and applied in all hotels which are Sokos and in all the S-group markets. It may help guide this business group to realize efficiency and transform Finland into a visually beautiful IT landscape (Cain et al., 2024). However, this procedure is rather time consuming and involves coming up with a new economic model before the technology comes into the S group market. Therefore in an effort to establish the net present value of the business research, it is necessary to enhance the secondary data (Chatterjee et al., 2024).

Additionally, Kahraman et al. (2024) said that a break-even analysis may just help come up with results that can allow the robot to be marketed. This effort is focused on the application of the automation technology that can raise the break-even analysis and the net present value of KPO. Here are some general asks aslo. Such as, How utilize of robotic cleaning system enhances cost advantage and generate better economical benefits to the hospitality industry? In what way do analyses of current and cheaper robots affect KPO's measures regarding productivity and environmentalism? or costs for this largest commercial institution are steadily rising on a daily basis. The high cost of labor is the main reason why this company lags behind (Yaşar et al., 2024). Because of this, automation of the deep cleaning process must be implemented in all Sokos original hotel locations as well as all S-group market locations and it might pave the path for this business group to achieve efficiency and turn Finland into a visually appealing IT circumstances. However, this procedure is rather drawn out, requiring the development of a unique economic model prior to the technology's introduction into the S group market. Consequently, in order to determine the net present value of the business research (Chambers & D.M., 2024), it is imperative to optimize the secondary data. Furthermore, a break-even study (Polonara et al., 2024) might yield results good enough

to release the robot onto the market. This effort aims to maximize break-even analysis and net present value for KPO while implementing automation technology in the cleaning process. The research leads to some questions:

- 1) How does the implementation of robotic cleaning systems in the hospitality industry improve cost-effectiveness and lead to better economic outcomes?
- 2) How do scenario analyses of existing and low-cost robots influence KPO's decisions on operational efficiency and environmental sustainability?

Thus, to respond to those research problems and related questions, this study is to develop a helpful economic benefit plan to enhance efficiency and decrease costs for the labor market of KPO and the S-group.

1.3 Objective of the Research

In this respect, this research can be a practical and useful solution to the hotel industry regarding the implementation of an automatic robot. It will study on the systems of this industry for the commercial factors such as; net present value, break-even analysis, data, security and sustainable environment. Furthermore, the outcome of this study will also investigate the usefulness of the impactful solution of the automation concerning cleaning, operational cost of the organization and customer satisfaction to put forward the better quality service. The present research aims at identifying the ways of applying robotic cleaning systems to improve the economic efficiency of the hotel business and its development. The emphasis will be on the cost-saving strategy to establish savings in terms of labor and operating costs together with the computation of Return in investment ROI (Ismanov et al., 2024). Furthermore, this research will also assess the effect of such savings to the overall profit and business viability in the hotels.

Automation is also used to enhance business advancement since it leads to operations and customer relations advancements (Banala, 2024). This research will look at different ways through which automation systems can promote sustainability and customer

satisfaction, and also the effect on hotel brands. The opportunities will include ways in which automation may help alleviate workloads on staff, improve cleaning durations and aid in the development of the hotel's future revenue model. In addition, it will assess the extent of the improvements in acquiring fresh customers and increasing market penetration with reference to automation as one of the strategic factors in the hospitality business. Lastly, this study will analyze the economic implications of robotic cleaning technology in the computation of the possible economic gains and losses associated with this innovation. The actuality will lie in the assessment of such threats of high initial costs, maintenance and data security issues to the opportunities of improvement of productivity and costs reduction. The study will identify ways in which data security breaches or upgrading of system can be a source of financial risks and proffer solutions for prevention by the hotels. This study shall provide a fair view of how, and in what ways, hotels can fully benefit from the economic impacts of automation without necessarily suffering.

1.4 Limitation and Significance of the Research

This research has a boundary because this research could not get primary data directly from S-group about the performance of cleaning robot because the company will still now trouble to manage the modern technology. Also, preparing the survey report for differentiated sectors of hospitality industry will be time-consuming because the process takes so long. However, the initial investment and operation constraints could be different from one another. Finally, this study has made an estimation that the cost of automation systems will not vary in the future which may not be 100% true when automating a certain system. Prior studies concerning the application of automation in hotel cleaning should positive outcomes, but prior attempts did not succeed because of technical constraints and a lack of comprehension of suitable application domains. According to Zaland et al. (2024), while adopting semi-automated systems may seem to reduce labour it did not actually do so much due to heavy intervention by people. Furthermore, prior robotic technology was out of reach of small or mid-sized hotel because it was not economical. (Kröger & F, 2024) mentioned that early robots were

expensive to maintain, and they could not bring the desired return on investments because many hotels did not scale up sufficiently. This divergence between technological possibilities and realized application is instructive for the present cycle of automation offerings.

1.5 Research Contribution

This research will seek to fill the gap between robotic automation and the possibility of its implementation in the hospitality industry, practically within the hotel cleaning function. While present works majorly aims at either constraint of the cost or aspect of the technology, this work can be seen to make a contribution under the charge that it presents an integrated model that accounts for all four elements of economic feasibility, operational efficiency and data security. A practical approach is taken based on my actual work experience involving automations in hotels and a realist approach comparing the advantages and disadvantage of implementations of robotic cleaning systems. Furthermore, the discussion with an explanation of the previous implementation's failure and provide a scenario comparison of current robots and low-cost options will help to work on not only assesses cost with npv and break-even analysis but also strategic implications for how hotels can implement sustainable robotic systems that can effectively replace labour, providing service benefits in the long run.

The change in cleaning process from manually to semi and fully automated cleaning processes can be described as a technology step up for the hospitality sector. Although previous cleaning methods and major efficiencies have been noted that they are tedious, labor extensive and not entirely efficient in delivering a uniform clean all over the surface (Victor et al., 2021). Autonomous systems are fixtures such as vacuum cleaners and scrubbers and are partially automatic with supervision.

1.6 Thesis Structure

This study is organized into several key points:

- **Introduction:**

Introduction explains the context of the research, the problem under investigation, as well as the research questions that this work looks to answer. It provides the information concerning the aimed goals and objectives of the research work, as well as the implied weaknesses alongside the increased importance of the topic noting the overall research's scholarly contribution. The following chapter presents general information about the structure of the thesis as the guidelines for the further sections.

- **Literature Review:**

The literature is reviewed in the context of the hotel cleaning practices, automation and the changing face of technology in the hospitality industry. To do this, the literature reviewed principles of cleaning, effects brought by machines, as well as shifts to robot cleaning solutions, leading to a development of the research framework.

- **Methodology:**

The Methodology section explains the nature of the research as qualitative and describes the development of the interviews and observations, strategies for data collection and data protection. This part explains how the research was conducted in order to achieve reliability and validity of the study.

- **Results and Discussion:**

This section aims to provide the result derived from the research study under the various analysis; cost analysis: fixed cost analysis, variable cost analysis, total cost analysis, break-even and net present value analysis and scenario analysis. It contains the evaluation of the economic impact alongside with SWOT and PESTEL analyses, and the case on the chosen robotic system.

- **Conclusion:**

The Conclusion reiterates the main implications of the research work and provides explicit answers to the research questions stated in the Introduction. It discusses the limitation of the work and how it can affect the hospitality industry and lastly consider a number of important research propositions for further studies owing to the contributions of the study.

2 Literature Review

Finland is one of the most famous countries in this world to the world tourism industry, and the hotel industry has been playing a special role in the economy for centuries. Saarinen & Lundén (2024) stated that it is not only to take care of the tourists but also show a reflection of attraction for the people. However, KPO and S-group has benchmarked a better image in different business sector like market, restaurant and lodges (S Group, 2023). Although there many hotels in Finland, Original by sokos hotel special among all those hotels because of its outmost clean environment (Timonen, 2024). The major phenomena of giving service to the world tourists and certainly internal customers with luxury. That is the reason of being one of the galmoruos hotels in finland which was estalished in 1974 in Helsinki (S Group, 2023). According to the report of S- group, day by day overall growth and service achieved a signficiant impact among poeple and therefore, it became associated with market, resturant and lodges. Sokos is very luminous among residential areas which are generally known world-wide and have become very magnificiant in terms of giving services to the world's tourists and certainly internal customers. It has a good reputation for beautiful and nice environment in different cities around Finland.

In Vaasa, there are nearly 285 of staying rooms since it is a commercial resort too as per the infromation of S-group. Among them a lot of rooms are being laxurious which has inside sauna and pool as well. Some of them are very higly decorated epesially focus on business customers and others are standards and it has several bars and inside food resturants, which has a massive array of options. In addition, there are three other very successful restaurants that also exist which cater both local and interntional cuisine. The most incredible thing is that it has a very good gym and a fitness center which is maintainng hygiene and, it has a large area in down stairs for parking and has more than five conference rooms and another meeting rooms. That makes total area of the hotel two acres. The event room is being utilized by some indsutralists and occasionally the university students also. A very important service that is offered to the hotel customers is free internet access to the internet For the delux customers other services such as

landry and cleaning services are offered. According to the report of Sokos hotel (S-group) most of the customers are traveller, business man, family and couple . It is very environmentally sensitive has the tradition architecturen and was especially recognized by the government several times. Beacuse of this fame this hotel needs to have more neat and clean. Meanwhile, KPO is spending a lot to keep this golory satisfied and the significiant amount are spending every year for the salaries of staffs . Furthermore, with the help of automation this company may save a massive amount of money every year which could help to replace the workers and introduce the cleaning robot around every sokos hotel in Finland. This research will be applied in the Royal Vaasa only as a trail of outcome of this business.

2.1 Overview of Hotel Cleaning

The work execution performed by sokos is as similar to another star hotel. The work distribution in general depends on shifts but main tasks are performed in a routine manner. For instance, a cleaner daily tasks includes are: vacuuming all parts of the home, washing them with clean water (sometimes manually sometimes using cleaning machines), then hygiene after cleaning (Bello et al., 2009). Even more seriously swimming pool and sauna areas are very sensitive because of the questions of hygiene and regular celebrations. Also, in almost all of the places that cleaners are requir concertrate on floor in which a variety of machinery is used to perform those functions. Besides, hosuekeeping is a mere handjob system and in which; machine cannot as well as play any significant role as most of the components are geared up in making beds and decorating rooms. However, in that case, regular floor cleaning could turn out to be a basic strategy to implement this research.

2.1.1 Overview of Manual Cleaning

Cleanliness as a factor is considered fundamental by the hotel industry because it touches on the existence of the brand and the guests' experiences in their operations (Yang et al., 2024). The historical-type cleaning process is very staff-intensive because in

order to make it standard, or widely-implemented across the various locations, it must employ numerous people. However, when it concerns the customer perspective, housekeeping is a significant hotel process with reference to the number of working hours dedicated (Victor & Aguilar, 2021).

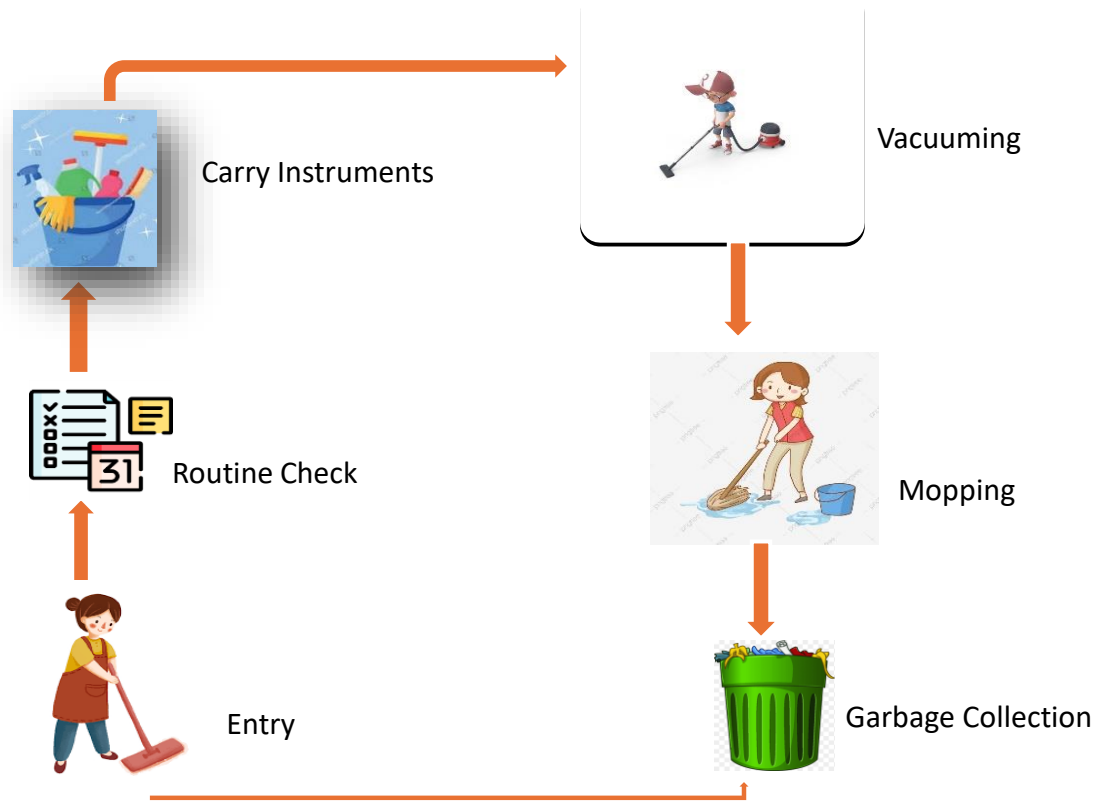


Figure 1. Manual Cleaning Process in Sokos Hotel

Also, there is information on numerous manual cleaning sector processes in various places and varies in different locations. For example, (Hussain, 2016) explained that the Finnish cleaning sector requires different machine types for it and that the hygiene maintenance. Generally, around the world cleaning procedures are like each other. It is referred to employees that use similar methods, including dusting, vacuuming, and sterilization (Das et al., 2024). Very importantly, due to high costs, it is impossible to gain

the greatest yield through maximum production together with huge machinery. The overview explains that a cleaner enters the hotel first and checks his routine. Then he carries the necessary instruments such as dry vacuum cleaner, mops and trash bags. Therefore several machines are used to clean some particular places.

2.1.2 Overview of Uses of Machines in Cleaning

In earlier years, several types of machines for washing and sanitation purposes have been developed to provide functional facilities to the various size of hotels. Semi-automatic and automatic devices that have been in use since the early 20th century are still in high use today (Kanaskar et al., 2024). Surprisingly, some cleaning evaluation and assessment activity started at begin with decreasing human interaction vacuum cleaners and floor scrubbers. In addition, different mopping machine models equipped with vacuum cleaners, mopping machines have gained considerable popularity in large sectors. Though the given devices offered ultra-fast channels and minimally limited the necessary time for cleaning, much human power is still involved. It did away with industry cleaning efficiency, undeniable but it lacked enough potency to eradicate the need for manpower.



Figure 2. Manual Cleaning Machines

In the same way, the USA, Canada and the Nordic countries have a tradition of heavy snowfalls that caused considerable damage to windows of homes and hotels during the past several centuries. However, given that such equipping entails proper washing process, which is a labor-intensive operation, these devices have not boosted the situation of the indoor and outdoor glass substantially. Therefore, the automation technology in hotel cleaning made everything quite easier, which is not practiced in every position of hotel. To sum, different type of vacuum cleaners especially both large and small, mopping machines, glass swiper etc. are very useful machines for cleaning quickly. Those machines are easy to use and have long-term efficiency in the cleaning industry.

2.1.3 Growing Trends of Robots in Cleaning

Automatic robots can perform several chores at one go such as vacuuming, floor cleaning and dusting because those robots are fitted with sensors, AI and auto robotic controls. Hence, AI has been introduced in the cleaning industry and both working efficiency and customer satisfaction are substantially enhanced from previous years (Borghini et al., 2023). By automating the detection process therefore, the system intends to eliminate leakage of manual inspection and provide better accuracy and efficiency. According to the study conducted by (Borghini et al., 2023) which mentioned that this AI driven solutions impact mainly on quality control practices, reduce the labor costs, and sustainable practices the hospitality industry in a significant manner.

They are considered in this way:

- A Sustainable and Green System
- Relations with Human Employees
- Automated Cleaning Technologies
- Increase in New Categories of Robotic Cleaning Machines

Cost Reduction and scalability in place when cleaning robots are introduced. Those robots have the capacity to handle multiple tasks at a time like vacuuming, floor cleaning,

and dust management as they are equipped with advanced sensors, artificial intelligence, and automation capabilities. While AI has been introduced in the cleaning industry both working efficiency and customer satisfaction increased significantly from previous years (Borghini et al., 2023) and by automating the detection process, the system aims to overcome the drawbacks of manual inspection and offer increased accuracy and efficiency. Borghini et al. (2023) described that this AI driven solutions effects quality control practices, reduce labor costs, and promote sustainability in the hospitality industry significantly. The improvement is considered as:

- AI-Driven Optimization
- Eco-Friendly and Sustainable Solutions
- Collaboration with Human Workers
- Data-Driven Cleaning Systems
- Rise in Specialized Cleaning Robots
- Cost Reduction and Scalability

2.2 The Evaluation of Automation in the Hospitality Industry

In the hospitality industry and more so in the management of hotels, automation technologies have been progressively implemented because of the desire in enhancement of the firm's performance and reduction of costs. Cleaning and housekeeping have always been heaviest labor activities and hence are deemed most appropriate to bear technological advances. While studying opportunities and challenges for automation in cleaning systems, early studies showed that future will likely bring both optimizations in terms of costs and problems connected mainly with ecological issues. Thus, it is possible to outline that numerous first attempts to automate these processes met certain level of resistance primarily owing to such factors as high costs in initial stages, and another challenge that refers to integration of new technologies with existing systems (Hussain, 2016). The idea of machines in cleaning industries beginning with introduction of vacuum cleaner in early 20th century (Zijl & R,

2024). However, the major breaking point was reached with designing robotic systems that are able to implement additional complicated processes of cleaning. Otherwise, AI augmented with AI and sophisticated sensors make it possible for today's cleaning robots to function independently for tasks like vacuuming, mopping and dusting (Gubhaju et al., 2024). This shifting means not only has a technological change, but also has emerged more trends about automated on the labor-intensive fields such as hospitality.

2.3 Shift Distribution and Work Plan

KPO and S-group's is taking better position in different vent of business like market resturant and lodges. The worker of the hotel is both internal and external sourced. Internal employeess consist of higher management level and permanent workers of KPO while external consist mainly in workers of different organizations working in shift system. The shift workers are divided into housekeepers, kitchen workers and cleaners.

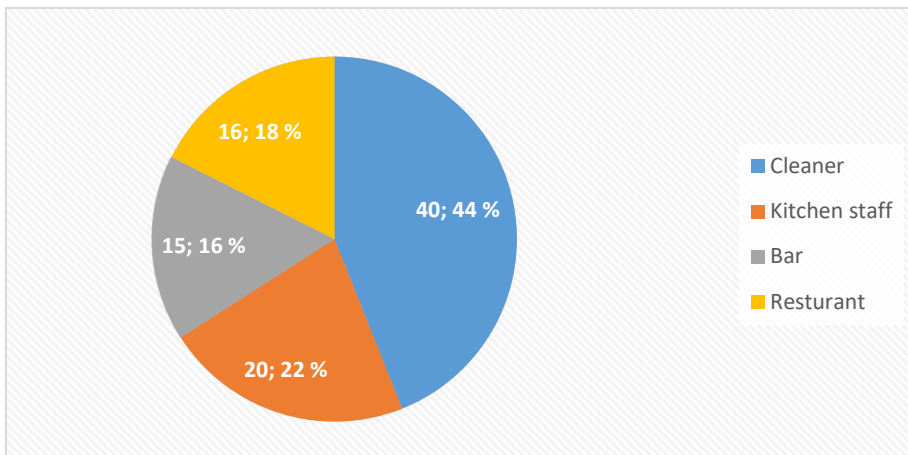


Figure 3. Shift Distribution in Sokos Hotel

Currently a specific star hotel has almost 15 cleaner's 20 housekeepers to perform certain tasks every shift (S-group 2023) that means 8400 hours almost took every day to execute hotel tasks. Otherwise, in a shift cleaning both morning, evening and afternoon

shifts have almost 20 cleaner and work execution of sokos is quite as similar as another stat hotel. The work distribution generally depends on shifts but main tasks are executed routine ways. For instance, a cleaner daily tasks includes are: vaccumming every possible place, mopping them with pure water (sometimes by hand, usually by machine), taking care of hygiene after cleaning. More importantly swimming pool and sauna areas are very concerning due to hygiene and regular parties. Furthermore, in most of the places cleaners need to be concentrated on floor where different types of machines are usually used to execute those tasks. Otherwise, housekeeping is basically a handjob system where machine can not play an important role as it mostly depends on bed making and room decoration. In that case regular floor cleaning could be an essential option to execute this research.

2.4 Salary and Effect

According to the primary data of sokos hotel management the current monthly bills are around 10000 Euros. Instead of that the employees need fringe such as tea, coffee, meals, costumes and specific training. Although this is a regular system, it effects more during winter as it becomes snow every where. Glass and other machinery workers then hire basically which enforces to regular salary of the employees. Wages and remunerations for employees, for example, meals, coffee and even work uniforms are very costly expenses in the hotel sector, for they are directly proportional to the economy of the many hotels. This is burdensome since labor cost is one of the leading expenses and limits profitability in highly staffed areas such as; cleaning and housekeeping. Secondly, offering fringe benefits definitely increases the costs of doing business since even during peak sales periods of the year, extra workers meant to provide the perks are necessary. Depending on the season, for instance, labor becomes scarce during the winter months, which puts any hotel under pressure to meet labor demands, hence the unpredictable expenses which require adequate budgeting. The other drawback of having fixed salaries and benefits is that the hotel cannot easily reduce its costs during the low business seasons, that make the hotel unprofitable due to inefficiency. Such costs build up over time and in the long run brings a lot of harm to the hotel because in order to meet the

new costs, it either has to increase its prices or reduce the amount of services it offers. They also help to eliminate most of the labor costs and improving the consistency of expenses and the general position of the hotels.

2.5 Maximizing Profit through Technology

Technology can be the source of profitability in several ways for the businesses, more especially to those businesses in the hospitality industry. AI and robotic solutions can reduce the labor factor significantly (Noorjahan et al., 2024) since several tasks can be automated, including cleaning and maintenance services, or similar customer interactions. This in a way minimizes the number of people needed to work and therefore salary bills and other associated employee benefits are kept low but productivity is not affected. Further, introduction of technology doubles the flow of business by reducing redundancies and making efficiency, energy and resources better managed (Ran et al., 2024). Salmona et al. (2024) described that sophisticated data analysis can be extremely helpful for businesses, as they can see through customer behaviours, and can better develop a successful marketing strategy, provide good and/or additional services, and ultimately make more money in result. In addition, through concepts such as online check-in, self-service and applications, the customers obtain more comfort, which results in increased satisfaction and thus increased occupancies and sales. In sum, the use of integration of technology increases profitability through decreasing the operational costs and increases the efficiency as well as increasing the customers' involvement.

This has previously included AI and other advanced technologies, the 4th level which combines fully automated methods with sensors and autonomous navigation demonstrates the highest level of operational efficiency due to minimum labor input and maximal accuracy. The literature review demonstrates that fully automated systems yield a direct monetary benefit to the company and offer other related advantages. Nevertheless, the choice of such systems is based on the size, financial resources, and requirements of the hotel. Automatic systems are most effective for use in large hotel

establishments, in which the size of the operation requires the need for higher investments. Scenario analysis supports the comparison of the benefits and costs of the current robotic structures and more affordable solutions. The indication of technology which is being used can depend greatly on factors ranging from hotel size and cleaning needs. For example, the models with enhanced cleaning capabilities provide a longer battery life and improved ways of maneuvering the device but they are very expensive and thus, unsuitable for small hotels. On the other hand, low-cost robots, despite being economical, many may not be capable of withstanding tough use, more so if they are to perform large scale cleaning jobs at once.

2.6 Analysis Structure of the Research

The case study, using break-even and NPV analysis on financial and operational benefits, demonstrates that robotic cleaning systems used in the Original Sokos Hotel produce considerable value. The key purpose of this research is to determine the viability of robotic systems as a solution to avoid employing human labor and to measure the cost-effectiveness of automation. The break-even analysis measures that the cost for €20,000 to integrate a robotic cleaner is offset in around seven months, in which the robot saves the cost of paying cleaners. When the cost of human labor is €10,000 per month against a robot of €200, then the net saving in a month is €9,800. This shows that penetration time to achieve break-even is very short in realizing profit and hence quick relief for labor-intensive operation of hotels. Furthermore, when the NPV is computed at a 10% discount rate for five years, the figure stands at €106,762, and the main argument is not only does the investment in the robotic cleaning system get recovered, but this is accompanied by even more benefits. In analyzing cost, fixed and variable has been established as mandatory so as to show the effects of financial on the hotel cleaning operations. Typically, fixed cost is used to mean costs that do not change as they occur. For example, that cost of buying robots cleaning equipments and its maintenance is regarded in this study as the fixed cost. On the other hand, variable cost involves the whole utility. Some examples include labor wages, cleaning consumables that are costs reflect on the current consumption levels. To determine the overall implication of an

economic study fixed cost and variable cost analysed for both the large and the small business organisation is crucial. According to Abraham et al. (2024) when fixed costs are excluded in production calculations, it gives an understatement of price-cost margins and an implication of overestimation of excess profit shares. It is seen that the fixed cost of hotel cleaning industry in finalnd is increasing sharply simply due to the digitization of the cleaning equipment, which requires to be upgraded rapidly. Hussain (2016) pointed out that Finnish cleaning sector has high fixed cost because of the technology requirement for maintaining cleanliness, which means that moving towards more automated cleaning equipment could bring transformational improvement on costs. In other respects, variable cost are affecting the anual profit because human labors has the greater contribution. Here are the calculation tools this research will follow:

NPV: Jones (2007) stated that Net Present Value is a another financial tool that is used to determine the outcome of particular investment. It measures the net present value of cash receipts or earnings over a specific period and compared it to net present value of cash disbursements or cost.

Break Even point : A break-even point is a concept referring to the point up to which the company, product or simply a project fails to make profits meanwhile it is also not incurring any losses (Moreno et al., 1982).

Fixed Cost: In other words, a fixed cost is an amount which is incurred irrespective of the rate of production or sales activity. Items such as rent, salaries well as insurance expenses come under this category. Such costs do not fluctuate with the level of output or activity of the company in question (Victor et al., 2021).

Variable Cost: On the other hand, a variable cost is a cost that changes according to the total level of production or sales quantity. For instance, they may comprise raw materials or supplies, direct wages or salaries and sales incentives. The total variable cost will increase to the extent of the number of units produced or sold.

Flexible Cost:

Overhead expenses also include flexible costs which are costs that are likely to change with the business operations or production capacity but they do not have a proportional relationship with production as do variable costs. Some of the possible examples of the flexible costs may refer to certain types of the utilities, or marketing costs, or, in the other record, certain extra expenditures which may be increased or decreased depending on the certain financial objectives, or market conditions.

The automated cleaning solution minimizes the expenses of operations throughout the duration of the business in addition to guaranteeing short- and long-term profitability in terms of organizational effectiveness and cleanliness. The predicted annual labor cost of €35,040 additionally leaves no doubt that the application of sophisticated robotic systems improves the profitability of operation in the hotel industry. Automation is also a great way of increasing operational efficiency. The robots operate for 8 hours within a day and have operating hours within a month, allowing the hotel to traverse large areas in a given period, especially the reception areas and corridors. Robot systems work effectively, cleaning while minimizing human errors resulting from exhaustion or lack of memory. Further, automation relieves human staff from repetitive responsibilities and enhances labor productivity and professionalism. Another advantage of robots is that they consume far less water and energy compared to conventional cleaning methods, and, since they do not get fatigued, productivity increases, especially during busier periods when impressive cleanliness is required to satisfy customers. Customers' feedback is highly positive, with many guests noting increased levels of cleanliness in rooms and other areas. Reducing contamination directly correlates with higher cleanliness scores, fewer complaints about room tidiness, brand enhancement, and customer retention. However, these successes do not eliminate a few initial glitches in the implementation process. Firstly, staff voice concerns for their jobs because they assume that computerization may eliminate human workers. Yet management is clear

that robots are intended to complement rather than replace human labor, as they are particularly effective at handling monotonous tasks best suited to automated systems. In this way, the staff learn the new system in the course of their work, and interaction between human operators and robotic systems becomes more efficient.

It will therefore be possible for this research to assess which of the robotic systems offer better value for money regarding KPO's cleaning requirement across varying situations. This will comprise of costs of acquisition, frequency of service, energy intake, and effectiveness of cleansing. The solution offered by this research should give a significant effect in the hotel industry on how to implement an automatic robot. It will do so by looking at the systems of this industry regarding business issues regarding net present value, break even analysis, data security, and sustainability. Moreover, this study will provide the outcome of the purposive solution to deploy automation in cleaning, the ability of the organisation to reduce the operational cost, and the satisfaction level of the customer which will be highly useful to develop the quality service. Break even analysis in this research shall establish the point at which the total cost of implementation and running the program will be equal to the total benefit. At the same time, it will propose cost-saving criteria through which the company can increase revenues. The framework in respect of break-even analysis is as follows, namely, recognize and ascertain the initial investments as well as the operating costs, examine revenue and cost savings factors, compute the break-even point, and evaluate the results. To perform NPV analysis there is a need to follow step by step approach. Therefore, the only solution for this research will be that the secondary data gathered from KPO itself will act as the ultimate database. Moreover, evaluating the collected information, the following steps will be taken in data analysis: identification of the initial investment, defining the annual cash inflow for the benefits, defining the annual cash outflow for the costs, choosing the discount rate, defining the time period for forecasts, and sensitivity analysis. Security of data remains a significant issue, which has to be addressed to adopt the cleaning robot within the broad hospitality establishment and for any other sector of the hospitality industry. The major areas of security for our study shall include namely

the following which are: policy on handling of sensitive data, user authentication, and security, data and records storage and disposal policies, measures of security in software updates, probability of data leakages, third-party vendors security measures, data de-identification, conformity to industrial standards, staff awareness on data security.

3 Methodology

For operating cost in a hotel, it is compulsory to have the explanation of fixed cost and variable cost for making profit and loss statement. Specific costs of the equipment used in cleaning are determined by fixed cost analysis, and any other costs such as employees' wages and cleaning products are arrived at through variable cost analysis. Hence, by introducing this automation, it is so easy for the organization to decrease variable cost, particularly labor. This study also improves the annual energy consumption and maintenance effectively. However, break-even and NPV are useful tools for determining the cost-effectiveness of robotic systems for cost saving and long-term returns. Anyway, as for me, data security is another critical issue of automotive tech which also strives to handle guest data. In conclusion, the comparison of completely automated systems, semi-automated systems, and manual systems discloses that fully automated systems give maximum possible efficiency.

3.1 Cost Structure Analysis Framework

This research firmly shows the financial and operational benefits of robotic cleaning systems in the hospitality industry. This thesis demonstrates that investment in robotic cleaners yields swift break-even, a higher NPV, efficiency, cost reduction, and service improvement as a model for sustainable living. The findings of this implementation provide a roadmap for exploring automation opportunities in other areas of hotel operations. Finally, this efficient project shows that automated techniques can revolutionize the hospitality sector through plans that are affordable, reliable, and, to some extent, sustainable. Moreover, this study indicates that up to 30% of cleaning time is reduced after implementing automation in every possible sector within KPO, especially in Sokos Hotel. The major outcome is that it brings about significant cost-effectiveness in the hospitality industry.

3.1.1 Fixed Cost

The classification of fixed costs in this research is based on the assumption that they are laden out independently of the degree of automation or occupancy. The idea behind this computation is to assess the predetermined investment in service and workforce of the hotel denoted as total fixed cost (TFC). The fixed costs are rent, salaries wages, insurance, depreciation and fixed utilities. Due to the fact that this hotel building belongs to S-Group and is in use, additional rental charge is not applicable here.

$$TFC = Rent + Salaries + Insurance + Depreciation + Fixed Utilities \quad (1)$$

- Rent: Stands for occupancy cost of property but this hotel is self-owned
- Salaries: Represents the monthly payroll for those fixed position that may not be changed because of existing automation.
- Insurance: A constant premium which are not influenced by occupancy or automation variations.
- Depreciation: It includes overall assets for a given life such as hotel facilities and equipment.
- Fixed Utilities: Concerns necessary utilities that remain continuously necessary to keep a hotel running.

3.1.2 Variable Cost

In this study variable cost refers to expenses that fluctuate based on the level of occupancy and include:

- Cleaning Supplies: Expenditure means the cost of washing consumables per room.
- Hourly Wages for Part-Time Staff: Payments made to casual or lowly paid employees based on the number of customers served or hours that were spent cleaning.

$$TVC = \text{Variable Cost per Occupied Room} \times \text{Occupied Rooms} \quad (2)$$

- Food and Beverage Costs: Since guest probabilities is high, cost like labor cost to prepare meals for guests, is high.
- Utilities (Variable Portion): That is – fixed overheads like salaries that are directly related to the number of guests using the facility such as water and electrical power bills.

3.1.3 Flexible Cost

Over head cost is the total amount of money which is usually incurred in the operational activity of some adjustable percentages. It also contains some utilizable factors such as electric or battery backup, maintenance frequency and energy usage of a particular duration. It instead relies with the demand of the uses of the devices and the percentage area that it can cover for cleaning at once. Semivariable costs vary with the level of activity in the hotel business and are also not directly proportional to occupancy. They usually comprise of a standard price and an added price that is usually dependent on use.

- Utilities: As noted earlier, the utility cost depends on fixed and variable categories, Such as electricity and water usage are likely to be inflated as the occupancy escalates.
- Maintenance Costs: Fixed cost also includes simple maintenance cost, but for other extra frequencies in using the facilities (like pools, gym, restaurants) the cost will not be fixed.

$$\begin{aligned} \text{Total Flexible cost} & \quad (3) \\ & = \text{Utilities} + \text{Maintenance} + \text{Food and Beverage} \\ & + \text{Laundry} + \text{Labor} + \text{Robotic Depreciation} \end{aligned}$$

- Food and Beverage Costs: The overhead costs attached to staff could remain constant, yet costs of raw materials in food and drink operation escalate with a higher number of guests consuming meals.
- Laundry Services: To the contrary, although setting up laundry services involves some capital intensive investments, the cost of running the services will depend with the volume of the linens used per every occupied room.

3.1.4 Break-even and Net Present value

Here, it is necessary to focus on a few key elements. For example, the initial investment, which consists of the cost of the robot, installation, and training. After that, compute the energy and maintenance costs of the operation and evaluate the cost savings associated with labor reduction and higher occupancy.

$$\begin{aligned} & \text{BreakEven Point (months)} & (4) \\ & = (\text{Initial Robot Costs}) / (\text{Monthly Cost Savings}) \end{aligned}$$

Here, Cash-flow will also depend on another variable named common discount rates and formal range will count from 5% to 10%.

$$NPV = \sum_{t=1}^n \frac{c_t}{(1+r)^t} - c_0 \quad (5)$$

Here,

C_t = Cash inflow during the period t

r = Discount rate

C_0 = Initial investment

n = Total number of periods

3.2 Scenario Analysis Framework

When analysing differences between the existing robots and the proposed robotic cleaning system, solutions that can assist companies in selecting automatic, semi-automatic, or manual modes are important. Several critical uncertainties will shape the future of robotic cleaning technology in the hospitality industry. First, the rate of technological advancement is pivotal, as rapid improvements in robotic functionality, precision, and cost-effectiveness could make robotic cleaning systems significantly more attractive. Faster advancements would lower maintenance costs, improve reliability, and allow robots to perform more complex tasks autonomously. Secondly, labor cost fluctuations are a major factor, as rising wages and benefits for human cleaners would increase the appeal of automation. Various scenarios will be analyzed in this study based on the hotel's information. The research will obtain a structured analysis and results by analyzing scenarios. Scenario will use a variety of tools to compare and contrast various hypothetical scenarios and in-depth analyses.

PESTAL (Political, Economic, Social, Technological, Environmental, and Legal). The potential for robotic cleaning systems is great, especially in view of trends towards automation and sustainability noticeable in the hospitality industry. Technological developments offer an avenue for continuous enhancement of the efficiency and cost of the process; the promotion of sustainability enhances the practice of the environmentally appropriate process in the world.

SWOT (Strengths, Weaknesses, Opportunities, and Threats) will offer a strategic review to determine the research's long-term viability. These systems are available at an estimated cost of around €20,000 and they come with smart navigation, multiple functions cleaning modules, and improved data security because these factors help in improving operational performance and reliability. Robot cleaning solutions provide the consistent and efficient cleaning high on demand from hotels that are looking for technologies for cleaning their facilities without human intervention.

3.3 Interviews and Observations

Multiple interviews were conducted for this research in order to make significant decisions for the case study. The interview has occurred multiple times online, in person, and even on a company visit. A number of KPO personnel and automation companies voluntarily shared their opinions in order to participate in this study.

3.3.1 Interview Design

The interview was of two persons made a significant impact in this research. It was taken place several times among the manager of Sokos Hotel and another is the founder of Done automation a commercial AI building company in Vaasa. The impact of the interviews brought out a massive data collection and execution outlines. The interviews were taken by face to face to face in two times and multiple times via zoom. In this study, structured interview was conducted with the Sokos Hotel manager Max to gain experts' knowledge regarding the benefits and costs organization in the financial and operationalization in using automation in hotel cleaning services. The interview yielded valuable information on aspects such as issues touching on cost in terms of the budget concerning the overall use of robotic systems; replacement of Labor; and challenging aspects of conveying the concept of robotic cleaning in the context of a hotel environment. For instance, the manager admitted an initial capital expenditure of €10,000 on exploring the robotic cleaning systems and future capital expenditure of up to €50,000 if savings are realized. Furthermore, the manager pointed out that a cleaning robot could be installed to the place of one of the workers relieving 10 hours of labour daily at an average cost of € 19 per hour. Other important considerations like, equipment maintenance costs, availability, material on the floor, and the inability of robots to eliminate human workforce were also talked about. These understandings have been incorporated into the calculation of cost savings where personnel costs and costs of the robotic equipment used in cleaning services will be compared to analyse the feasibility of implementing automation in hotel cleaning services.

Apart from the interview with the Sokos Hotel manager, a structured interview was conducted regarding the views of Thomas Houglund, the founder of Done Automation; this interview sought to unveil the possible automation in cleaning sector. Houglund offered valuable input for future design and purpose of the robotic systems used today in Finnish hospitals in Helsinki. He described the need for hardware components in robots and cost analysing them and provided insight into how this type of robots could be used in cleaning operations in a hotel. Houglund also helped to analyse the work automation can lead to within the scope of costs, the prospects for receiving further financial benefits, and increasing the effectiveness of work done. His input sharpened the economic analysis instrument of evaluating robotic cleaning systems as far as capital costs necessary for building these units, as well as the operations savings of these robots are concerned.

3.3.2 Data Collection Process

To gain a comprehensive understanding of the potential and challenges of automation in hotel cleaning operations, data was collected through two semi-structured interviews with industry experts: Sokos Hotel's manager and Thomas Houglund the founder of Done Automation. Such interviews proved insightful in terms of identifying functional specifications that need to be met by a robotic system as well as the economic viability of a robotic system in a hotel environment. The interview conducted with the director of the Sokos Hotel was aimed at identifying hotel's view on the financial and process consequences of implementing robotic cleaning options. Key data points included: Budget considerations: The manager presented approximate market shares which shows first estimated 10000€ for testing and future potential investment of up to 50000€ if efficiency results are observed. Labor replacement potential: The manager assumed that a robotic system could do the full time scrubber, save around 10 labor hours per day with the cost estimate at € 19 per hour. Operational challenges: The manager precisely marked those aspects explaining the applicability of automation, including proximity, surface and material type, required cleanliness, and care frequency; there emphasized that automation would only supplement the removal of human labor in some degree.

The interview with Thomas Hougland of Done Automation offered a technical and economic perspective on robotic systems: System design and cost structure: Hougland explained the type of hardware and costs of the robots utilized in Finnish hospitals today as well as their operation, thus offering a useful similarity to hotels. Automation insights: They examined how robotic cleaning solutions work in diverse settings and talked about flexibility of robotic cleaning operations across the type of surface and cleaning requirements in hotels. Economic outcomes: Initial costs of automation, costs of labor that may be saved, and time frame in which the expense can be recovered were highlighted by Hougland in his work and formed the basis for the economic aspect for this study.

Considering the level of human involvement needed for watching robot actions, responding to the appearance of obstacles, and coping with failures in robots, which affects labor costs and savings potential. Noise and Disruptions: The effects of robots on thereby increasing the hotel ambiance particularly in the relatively silent or customer friendly regions where noise from robot cleaning might be disruptive. It became possible with the help of these observation techniques, as they also delivered the key practical knowledge about the strengths, flexibility, productivity, and limitations of robotic cleaning services in the case of a hotel. Together with interview data, these observations contributed significantly to developing the strengths and weaknesses of automation in hotel working processes for determining key financial and operational benchmarks for feasibility analysis of the project.

3.3.3 Data Security Process

Every time the hospitality industry applies automation, the issue of data security comes up as the biggest concern. In an automated system, for both software and hardware, a particular system gathers and analyzes fairly significant amounts of run-time data, namely: room occupancy, cleaning timings, and potentially guest interactions. Furthermore, the significance of data security is underlined by several related works on the threats of data leakage, misuse and data manipulation. The ideal practices in data

management such as storage, encryption and decryption consistent with the standards of the industry are extraordinarily important in the security and integrity of the data gathered by cleaning robot.

On the other hand, full data handling training for the employees and the maintenance workers, as well as the third-party vendors with sound security measures added to the program are the main components of a robust protection system. To sum up, KPO will have a massive possibility to get a sustainable profit margin in future after implementing automation. Overall, after seven months it will reach at the break even to gain the maximum level of outcome.

4 Result and Outcome

As per the analysis, investment on robotic cleaning systems at the Sokos Hotel will be cost effective, enhance operating efficiency as well as sustainable benefits. By the evaluation of the break-even analysis, it can be stated that the nursing home can cover all costs connected to the robotic cleaning systems during seven months, beginning from the amount of investment in the amount of € 20, 000. After this the hotel will be able to save €9,666 in savings that indicates massive fortunes in long run. Last of all, the Net Present Value (NPV) calculation which gives €106762 approximately points to this investment need more than the cost of implementing the robot during the 5-year utilization. Also, the use of robotic systems will enhance the overall organizational productivity pull through faster cleaning work in thirty percent and stress personnel on complicated work in addition to ensuring the improvement of the employee and clientele satisfaction. Some surveys involved among the visitors of the hotel revealed that the respondents have noticed a higher level of cleanness and sharper service delivery standards that correspond to the brand associated with the hotel. This particular technology will also help the hotel to meet its sustainability goals such as conserving water and cleaning chemicals that is used in the process. In total, it is possible to conclude that the subject of the robotic cleaning system is possible to estimate as valuable investment potential contributing to the changes of the companies' financial and business performance.

4.1 User Case

One of the biggest changes in the housekeeping of Original Sokos Hotel has taken place with the introduction of robotic cleaning systems. Firstly, a small test was conducted through AUT and a new robotic cleaner was used on trial in specific areas like entrance and corridors etc. This approach enabled the hotel staff to determine the efficiency of the technology and offer feedback that can be used improve on its use. After a pilot of the robotic system for buffets, the robotic system can be applied to guest room cleaning and this has led to a decrease in cost of labor and an increase in the rate of cleaning. The

experiences of the staff members revealed that it was easy for them to concentrate on higher tasks and core activities as the robots undertook stock intestinal work making the employees happy with their new jobs. Customer's will have the opportunity to report more cleanliness and good service delivery as a result of adoption of robotic systems as a core business component in the hotel. In a word, the user case explains how embracing innovative cleaning solution can improve service delivery and become a competitive edge in the operation of hospitality business.

4.2 Fixed and Variable Costs Analysis

In this scenario, the utility remains same, and hotel does not have any extra rent as it is occupied by S-group itself According to the equation (1)

$$TFC = 10,000 + 1,000 + 4,000 + 1,500 \quad (6)$$

$$TFC = 16,500 \quad (7)$$

According to the primary data cleaning supplies are €5 per room where hourly wages for Part-Time Staff is €8 per room (average) and variable Utilities are €2 per room. Assume that hotel has 20 occupied rooms.

$$\text{Variable Cost per Occupied Room} = 5 + 8 + 2 = 15 \text{ euros} \quad (8)$$

As per the equation number (2) total variable cost is:

$$TVC = 15 \text{ euros} \times 20 \text{ rooms} = 300 \text{ euros} \quad (9)$$

By adding equation no (7) and (9)

$$TVC = 16,500 + 300 = 16,800 \quad (10)$$

Total Fixed cost is 16,800 and Variable costs is 16,500 and Total expenses that fluctuate based on the level of occupancy. It also depends on cleaning supplies, part time staffs and utilities.

4.3 Flexiable Costs Analysis

First of all, it is necessary to analyze the details given to us on flexible costs in the sphere of hotels' activity. Variable cost can also be called semi-variable cost, and these costs fluctuate depending on the level of hotel operations, for instance, depending on occupancy level. They have both fixed and variable components and that is why cost volumes are essential to analyze the level of operational activities and profitability. These vary with occupancy in that the former rises as the latter rises. For instance, direct expenses such as €1,000 spent on electricity per month may shoot to €1,100 if number of guests and a particular capacity by 100, with every subsequent additional 100 guests attracting an additional 10% added to the expense. If total montly labor expense is €10,000 and horly wage €19/hour the total hours and depreciation is:

$$\begin{aligned} \text{Total Hours} &= (10,000 \text{ euros}) / (19 \text{ hrs}) & (11) \\ &= 526.32 \text{ hours Approximately} \end{aligned}$$

$$\text{Annual depreciation} = (20,000 \text{ euros}) / (5 \text{ yrs}) = 4000 \text{ euros per year} \quad (12)$$

$$\text{Total Flexible Cost} = 2,000 + 600 + 10,500 + 600 + 10,000 + 333.3 \quad (13)$$

Which is 24,000 approximately per month

4.4 Break-Even and Net Present Value (NPV) Analysis

The break-even analysis of this research will involved the use of two factors. They are the total cost and the total benefits. The monthly labor cost sum is £ 10000, and the

robot is £ 20000 (its validity is five years with the depreciation). Purchase, installation, and operation are included in the total cost, and labor savings and increased customer satisfaction will process the costs. Here are some important consideration:

Robot expense: €20,000 (one-time investment), Current Labor Cost: €10,000 and Expected Lifespan: 5 years. Since the robot will take €20,000 and lasts for 5 years (60 months). Therefore, monthly cost of the robot is:

$$\text{Monthly Robot Cost} = 20000/60 = 334 \text{ euros per month} \quad (14)$$

After replacing the human workers with the robot net saving will be:

$$\text{Net Monthly Savings} = 10,000 - 334 = 9666 \text{ euros} \quad (15)$$

As per the equation number (4), initial break even point is:

$$\text{BEP} = 20000/9666 = 2.07 \text{ (approximate)} \quad (15)$$

The estimated break-even point is around 2.07 months; it is the time when the costs of humane labour could have been paid for the use of this robot. Then what is left will be the lifespan of the robot which is approximately 769 hours per month.

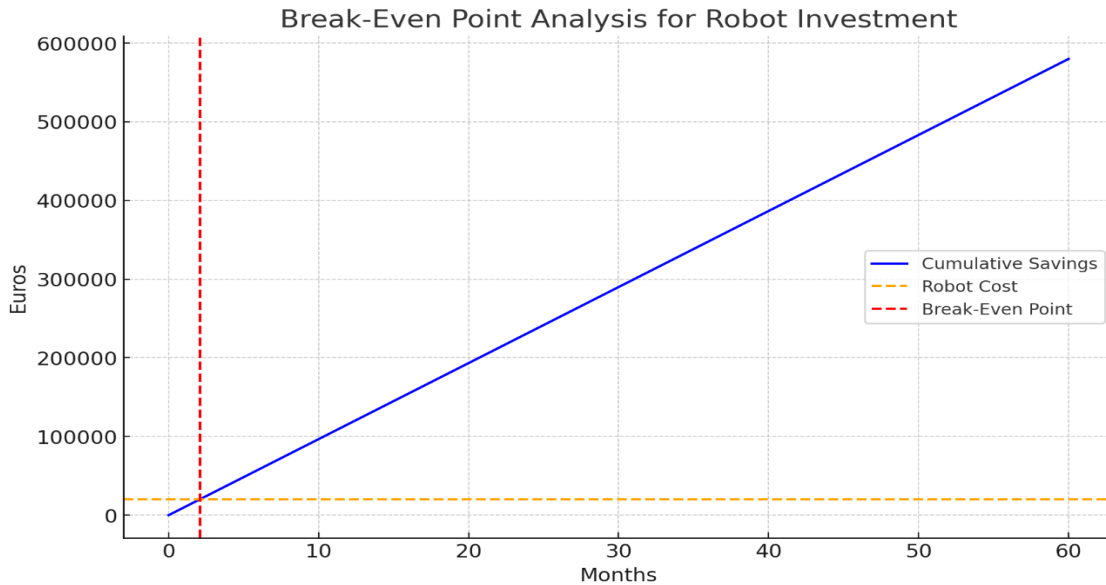


Figure 4. Break Even Point

When the robot will be implemented in common spaces per day only for the floor then it will work almost 8 hours in the total hotel area. For this reason, monthly saving in a month will be 3,120 euros.

To evaluate a break-even analysis by comparing the labor cost and the hours the robot works; the following steps are:

- Robot cost: €20,000 (one-time purchase).
- Robot working hours per month: 240 hours.
- Labor cost per hour: €13.
- Human labor monthly cost: €10,000.
- Savings per month using the robot: € 3,120

Monthly Savings

(16)

$$\begin{aligned}
 &= 3120 \text{ euros (labor savings)} - 334 \text{ euros (robot cost)} \\
 &= 2,786 \text{ euros per month}
 \end{aligned}$$

Final break even point will be:

$$\text{BreakEven Point (Units)} = 20000/2786 = 7.18 \quad (17)$$

The payback period is almost 7 months. In this period, the robot will create its initial capital of the price of the robot, and the other 52 months will contribute toward creating savings.

To understand the Net Present Value (NPV) of the investment in the robot, cash flows, the discount rate and associated with the investment should be considered as 33,400 euros. In this analysis, let's assume 10% as the discount rate.

Implementing equation (5)

$$NPV = \frac{33400}{(1 + 0.10)^1} - 20000 = 31850.91 \quad (18)$$

For the next five years NPV will be:

$$\begin{aligned} &\approx 30,400.04 + 27,636.40 + 25,123.09 + 22,839.17 + 20,762.88 - 20,000 \quad (19) \\ &\approx 106,761.58 \end{aligned}$$

The cost of the robot is €20,000 while the value in the investment for the production of the robot is €106,761.58 of net present value. This positive NPV implies that the investment is financially feasible since the perceived discount rate used in the cost of capital determination was more than covered by amount of money that the robot was able to pay. Hence, breakdown of BEP and NPV provides relevant and useful information where investment on cleaning robot in the hotel industry is concerned. The break even table reveals that €20000 is fixed cost which include the cost of acquiring the robot and the case for the robot as a substitute to human labour is apparent within 7.18 months of operation. At the same time, the NPV of the investment is also positive and amounts to € 106,761.58 and therefore, dominates the said cost during its operation, and in

addition, will produce considerable sales throughout the useful life cycle of the investment.

4.5 Scenario Analysis

If labor costs continue to escalate, robotic systems could provide substantial savings over time, accelerating their adoption in hotels. Lastly, guest acceptance and regulatory impact present significant uncertainties. While some guests may appreciate the innovation and cleanliness consistency robots bring, others might view automation as impersonal or even invasive. Additionally, regulatory bodies may introduce strict data security and employment regulations that could impact deployment and increase compliance costs. These factors together will determine the speed, scope, and feasibility of robotic cleaning technology adoption in hospitality.

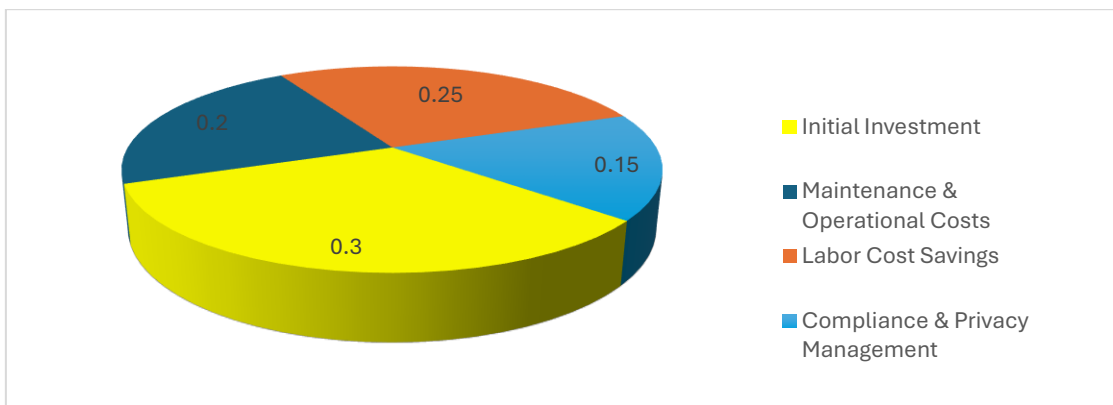
4.5.1 Full Automated with Technological Advancement

In this case, technological progress extends in robotic cleaning systems so that robots become much more efficacious and economical. Likewise, the costs for labor are still on the rise, thereby making automation even more attractive in terms of minimizing costs. There are several forms of cleaning automation: here, the most developed, but also requiring significant investments in robots, is the complete automation of cleaning and the exclusion of human staff. First of all, this model implies a high initial investment; the establishment and functioning of robotic cleaning systems are more expensive than manual or semi-automated methods. Nevertheless, on this front, the long-term side is that of benefits rather than costs. As is seen, the majority of costs were taken by labour expenses; they shrink remarkably, from €20 to €6 per hour because of minimum human engagement. The operating cost of robots also decreases, from €20 to €6 per hour, as the use of automation technology advances and becomes cheaper. According to the data of Sokos hotel this scenario will be:

Table 1. Automation Initial Input

Content	Cost
Total Initial Investment	30,000
Maintenance and Operation	20,000
Labor Saving	25,000
Compliance and Management	15,000

The end up being is less labour costs while operations achieves its maximum productivity thus the high ROI. Foremost automated cleaning systems are suitable for hotels with an aim of achieving the longest sustainable length of the equipment and cost conservation in the farthest reach.

**Figure 5.** Technological Advancement vs Labor Cost

4.5.2 Semi Automation with Stable Labor

In this environment, robotic cleaning technology advances at a slow pace, enhanced by marginal advancements in capacity and concomitant high costs. Although it involves a moderate amount of capital investment that is relatively lower than that used in fully

automated systems, the major source of finance comes from the minimization of human resource input. Wages costs are reduced over time, hourly wage rate ranges from € 14 to €18 in year 4 when most of the mundane task are completed by the machines. Consequently, the cost per hour of operating these machines is expected to decline from € 18 to € 10 per hour, due to continued minimization of human input and increased mechanization of equipment. This scenario provides an average return on investment, especially because initial investments are followed by gradual and progressive operating costs. Partial automation is also ideally suited for improving efficiency of work processes in those hotels that cannot afford large investments in new technology right now but are ready for automation to become a part of their operation soon. This approach is highly advantageous for facilities where staffing issues are an issue, but in which full automation remains unmanageable. According to this scenario, it can be understood that robotic systems might be integrated in the certain field of hotel processes but they will not severely displace people. Such cost savings may only reach 10 – 15% over a relatively long period when costs of operations are being considered.

Table 2. Automation and Human Cleaning Comparison

Session	Human Labor Cost per Hour (€)	Robot Operating Cost per Hour (€)	Total Hours Worked by Robots (per year)	Total Human Labor Hours (per year)	Annual Labor Savings (%)
1	13	18	5000	10000	0
2	16	15	6000	90000	5
3	15	12	7000	8000	10
4	14	10	8000	7000	15

4.5.3 Manual Cleaning with Machines

be costly since wages continue to rise—while the present hourly rate is €13, it is projected to rise to €21 in future, which may strain hotel resources. This setup does not necessarily need a massive setup capital as the major input is human effort as compared to machinery. However it gives low return on investment (ROI), due to reappearance costs in labor intensive operations this though comes with little variation in productivity. Wages constituted a large part of total expenses, which is why we can rarely see an improvement in multiyear financial performance of hotels. Though effective the methods of cleaning are not easy to upscale the cleaning services without incurring high costs with a rising cost of labor in the hotel industry. This situation fits small players or hotels which cannot afford large investments in automation processes. In such case there is high muscle to robotic technology in mid-range while high steel from the guest and regulatory agents as well as high threat from privacy, job security and data security. The use of robots would have to be standardized and data protection measures want be put in place, the compliance costs will go high. The guest experience can be mixed some see the innovation as positive while others may be displeased.

Small scale utilization would ensure the ROI remained reasonable, and the robots would assist the cleaner instead of replacing them. This suggests slow integration of robotic cleaning systems and therefore would take longer time to reduce the cost by about 20-30% but in the process incurring much higher regulatory costs. According to the Table (1)

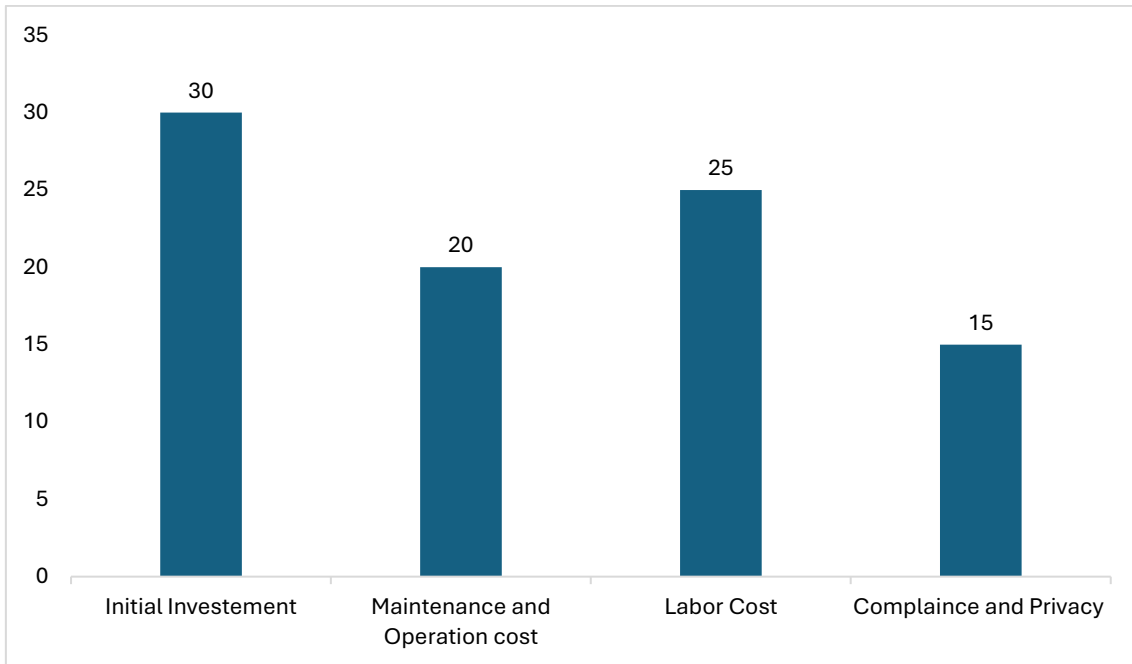


Figure 6. Manual Cleaning Scenario

4.5.4 Comparison of Scenarios

This is an area of research that has been under focus in the current world as the comparison between manual, semi-automated and automated cleaning systems. Although manual cleaning is efficient, it is time-consuming and expensive because employees charging an expensive wage are used to ensure cleanliness. Compared to fully autonomous, fully manual systems are more popular in various sectors; mid-range technologies like floor scrubbers and vacuum cleaners take over some work but still need human supervision. Completely autonomous robots recommend the highest levels of operational functionality where a specific process exists and is carried out entirely without human interference. According to (Svanberg et al., 2024) fully automated systems can successfully remove most of the labor costs for cleaning and reduce the cleaning time thus increasing the profits of the management in the hotel. When a digital appliance for cleaning is utilized, comparing manual, semi-automated, and fully automated makes a perfect environment for the device applications. However, it is costly as it requires several workforce due to high wages required to ensure that a hospitality organisation maintains high level of cleanliness.

This thesis quantitatively evaluated the feasibility of adopting robotic cleaning technologies in the hotel industry and the effects of doing so by analyzing scenarios. The analysis compared three distinct scenarios: , elementary automation with mechanical scrubbing and sophisticated automation through robots. It is apparent from the results that cost difference, operational metrics, and ultimately, the ROI vary greatly among these scenarios.

Table 3. Labor Vs Automation Outcome

Scenario	Estimated Labor Costs (€ per hour)	Estimated Robotic Costs (€ per hour)	ROI (%)
Manual Labor-Intensive	Increases from 13 to 21	18	Low
Semi Automation	Decreases from 14 to 18	Decreases from 18 to 10	Moderate
Full Automation	Decreases from 20 to 6	Decreases from 20 to 6	High

Analyzing the three operational scenarios: manual labor-intensive operations, partial automation and full automation, it becomes clear that these models differ a lot in terms of financial performance and effectiveness of operations. While in several labor-intensive industries, labor costs are still high due to escalation of hourly rates, the ROI is insignificant, since high operational costs do not bring proportionate productivity returns. Partial automation also requires a moderate capital outlay in automation with the continuing employment of people, hence, reduced human costs from the robotic tendency to undertake repetitive actions. More precisely, this scenario is characterized by a moderate level of ROI, when initial expenses are recovered through successive savings on human resources and progressive changes in organizational performance. The severest form we have is full automation, which has a strong argument because it involves dispensing human beings completely from performing cleaning tasks using robotic systems that are more expensive to install than partially automated cleaning systems. Happily, this approach leads to impressive DOM, thereby minimizing all operating expenses in the long run and a high ROI since the major cost, labour, has cut

down drastically in the future. As technology in automation advances and expenses begin to lower, full automation surfaces best the financial option forward for hotels and the best readiness for an efficient working agreement lies ahead.

Implications for the Hospitality Industry. The findings of this research indicate a strong incentive for the hospitality industry to invest in robotic cleaning technologies. As labor costs continue to rise, transitioning to automated solutions offers not only cost savings but also enhanced operational efficiencies and service quality. Stakeholders should consider the long-term benefits of full automation, particularly as the market for robotic solutions matures and costs decline. The scenario analysis underscores the potential for a significant shift in operational strategy, paving the way for more efficient, cost-effective, and sustainable hotel management practices.

4.5.5 Outcome of Scenario Analysis

The examination of the outcomes in the three operational scenarios shows the strengths and weaknesses of each of the strategies. The most preferable market conditions are presented in the first use case (Full Automated with Technological Advancement) since increasing technological suitability of robotic cleaning fits best to the costs decline. In this case, the returns for the hotels can be very high since the efficiency and effectiveness of system overcomes the manual approaches that use man force. On the other hand, the second one seems to be more unfavorable because of the specified slowness of the technological factor while labor costs remain stable. This stability reduces the desire for the hotels translate into other methods of cleaning such as robotic cleaning hence the hotels have limited operational boost and lower returns on investment. In contrast, the third scenario depict a middle ground of the strategy since it incline to the resistance from guests as well as latency to face some important regulatory factors that concerned of applying automation in the hospitality industry.

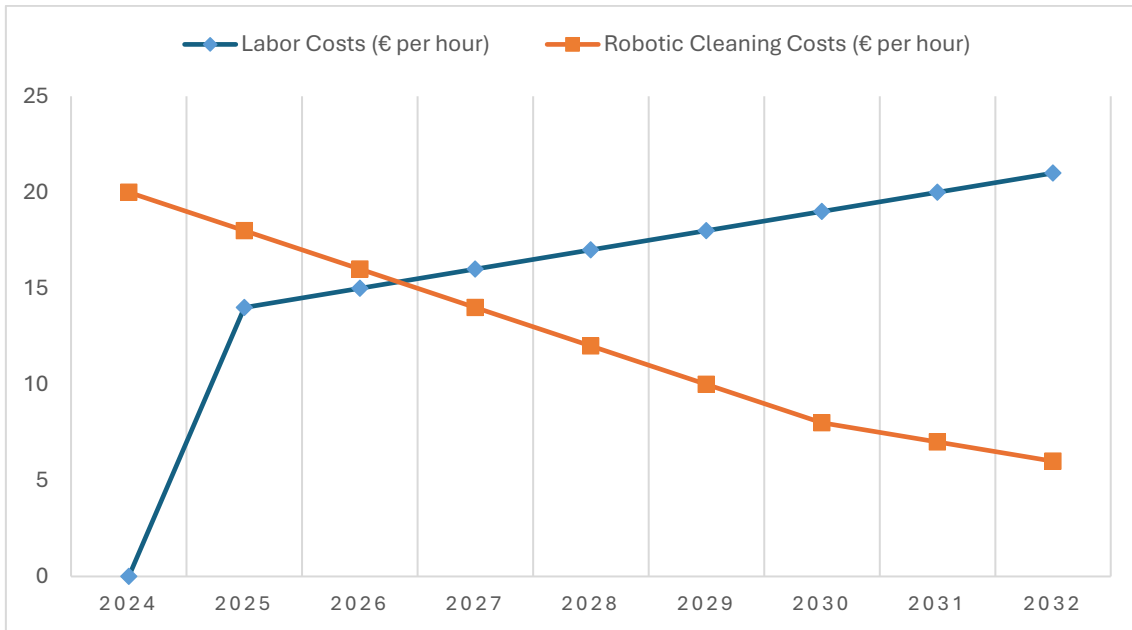


Figure 7. Scenario Analysis Outcome

The Full Automation scenario demonstrates the highest cost savings and operational efficiency but has a moderate guest perception and regulatory compliance score. This makes it the most advantageous from a financial and operational perspective, as indicated by the highest values in efficiency and cost savings, though some guest perception concerns exist. The other scenarios, while beneficial in guest perception and regulatory compliance, lag behind in efficiency and cost savings, making Full Automation the most favorable choice for significant cost reduction and performance improvement. This moderate approach is a slower process where robotic implementation is carried out in a measure by measure manner through observing the reactions of the customers or stakeholders so that the technique is not hostile, making this an implementable idea easier for hotels that need to change but do not want to lose customers in the process. In summary, the results show that there is a significant money-saving opportunity in full automation, but it requires ponderous attention to market factors, technology neritization, and guests' impressions. Therefore, although total automation is beneficial for significantly high long-run performance, knowledge management needs to factor technology, legislation and customers. The first scenario can only be ideal for any hotels

where labor costs act as a sensitive issue, and they have properly embraced technology readiness level, and meet regulatory and customer satisfactions. While the ROI in the third scenario may be lower, making use of it could be more reasonable for hotels that want to enter the automation market without radical changes.

In addition, it seems very challenging for a person to manage the aspects of brightness and general cleanliness and this affects the quality of the hotel industry. To avoid these inconveniences, the semi-automated type was innovated and brought into the market at 1930 and 1940. In cases of semi-automated systems, then floor scrubbers and vacuum cleaners became important due to the massive time saving and perfect methods that they offered. It was also disclosed to the market since human effort is not much necessary to control it but still requires human supervision to control those machines. Otherwise, a fully automated system selects the ultimate level of working efficiency because it can do every job without the workers' interference (Parekh, 2024). That is way, in this digital transition period, a fully automated system is significantly important to gain the perfect cleaning operation and make the sector more profitable. If not, it will be extremely difficult to break even on schedule. The components of the suggested automated system will include a garbage collecting bag, a floor scrubber, an inside vacuum cleaner, and an inside mop. Additionally, it will take care of hygiene once.

4.5.6 Comparison of Cheapest to Expensive automation Models

The signal of low and high price cleaning robot relates has some core distinction. For instance, cleaning capacity, the degree of effectiveness, electronics and total performance. In the comparison of the high and low price robot cleaners, it is evident that the differences center on only budget and operational equipments. Table indicates that price has relation with some components and cost also. The major differences are basic navigation and advanced navigation.

Table 4. Model Expense Comparison (www.amazon.com)

SI NO	NAME	PRICE	FEATURE	YEAR OF INNOVATION
1	Zerodis	\$20	Rechargeable Sleping Vacuuming Mopping 3 in 1	2020
2	OKP K3	\$89	Strong Suction Voice Control for Hardfloor	2021
3	V3s Pro Robot Vacuum Cleaner	\$ 159	Automatic Self-Charging Robotic Cleaner, Hard Floor and Low Pile Carpet, Pearl White	2018
4	AIRROBO	\$129	Wi-Fi/App/Alexa, Self-Charging Robotic Vacuum	2021
5	Dreametech	\$349	Self-Emptying for up to 65 Days, Ideal for Pet Hair	2020
6	UBPET	\$499	High Suction, Ideal for Carpet	2022
7	Eureka J20	\$1099	Vacuum and Mop Combo, Auto Washing & Drying	2021
8	ECOVACS DEEBOT	\$1199	ZeroTangle Technology, Adaptive Edge Mopping	2019
9	NOESIS	\$1599	Auto-Changing Mopping Pads,Obstacle Avoidance	2023
10	dreame X40	\$1899	Ultra Robotic Vacuum with Removable & Lifiable Mop	2022

From the above data, initial cleaners are relatively cheap and begin at \$20 USD, which does not favor the 'middle income' consumers. At the present time, the cleaner is produced with a computer; it is not semi-automated, nor is it partially automated. Then

there is an automatic cleaner that may be used for cleaning in small areas and its price is 400 USD.

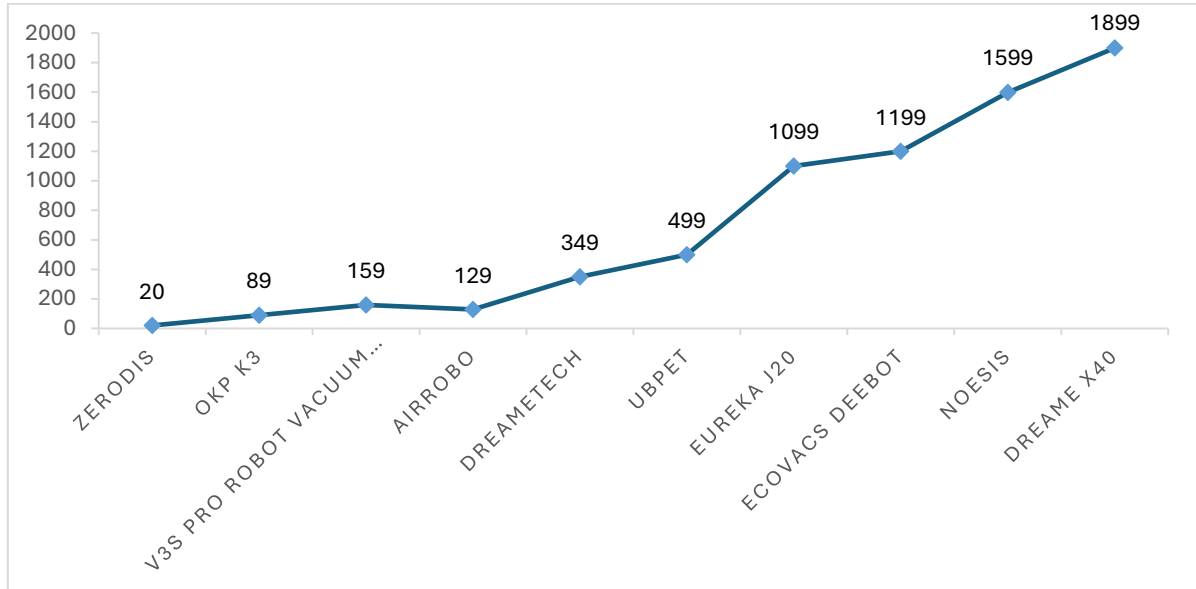


Figure 8. Market Price Comparison

4.5.7 Explanation of Scenario

The proposed robotic cleaning system costs €20,000 and designed to work uninterruptedly; it has been expected to last for five years with normal usage expected in a hotel environment. This considered, operation has been assumed at high traffic density areas like, lobbies and hallway, on a daily basis. And as we learnt, if the system is maintained constantly, it will not degrade significantly before the major components of the system need to be swapped out. However, cheaper models of robots currently being sold in the market have shorter lifecycle of about 1 to 3 years owing to less electronics, complexity and relatively fewer applications.

Sustainability and Upgradability : One of the issues that team for the proposed robot have incorporated is the ability to make future enhancements in both the hardware and software of the robot. For instance, there have been new applications designed to improve the control and navigation or cleaning, and this means expanding the useful life

of the initial investment. This can be compared to the existing robots that are non-upgradable a lot of the time, meaning that whenever newer models are released on the market, the existing robots have to be replaced completely.

Constant and Variable Factors: The total cost of ownership for the proposed system can be broken down into both constant and variable costs: Other costs cover the fixed cost to start-up the business (€ 20000) and fixed cost like, maintenance contracts & software subscriptions. Fluctuating costs include energy used by the machines, expendables such as filters and cleaning solutions, and repair costs which may rarely occur. For example, it is intended to cut the labor expenses by €2, 000 every month. Though fixed costs including employees may range between €500 and €1000, other expenses like power and expendables may cost approximately €50 – €100 every month, which is quite affordable as compared to employing human power.

Technical Perspective: From a technical perspective, the new proposed robot is characterized by a sophisticated Artificial Intelligence based navigation system , which involves vacuuming, moping, and sanitizing , and robust data protection that is not common in most models. Its physical structure is durable to enhance uninterrupted performance, and adaptability of the equipment to different working conditions, such as in hotels where hygiene is a major factor. It also supports hotel management systems for real-time report generation and scheduling which requires minimal supervision.

Economic Perspective : Economically, of course, the initial cost for implementing this model is higher than in other approaches; however, in terms of ROI of labor cost, this number is expected within 6 months . It makes it a good financial choice for hotels that wish to improve on the overall operational capacity of the business. On the other hand, current robots with less amount of initial investment (€1,500-€10,000) demand higher running costs in the long run as it involves higher level of human interference and frequent maintenance.

Technical-Economic Combination: It is the superiority in terms of technology merged with the another important factor for the economic soundness of the proposed robot that places this product in competitive advantageous position in the markets. Its sophistication eliminates operational losses and translates to great savings on labor costs, minimal time off, and lower recurring maintenance costs despite the relatively high initial cost. This robotic system is a comprehensive solution for supply chain automation since it combines automation technology and a coherent economic model to establish the optimum balance between capital investments and payback in hotels.

The results of this investigation shows how realistic and useful it is for users such as KPO. Implementing the many hotel perspectives, and this analysis will add value for the hospitality sector by enabling it to adopt the best one.

4.5.8 SWOT and PESTAL Analysis

Under the conditions of growing changes in the hospitality industry, the application of robotic cleaning systems may have certain benefits to increase the efficiency of operations, minimize costs and improve the environmental impact. Hotels are constantly experiencing the pressure to increase service quality and downsize labour expenses, causing the demand for the robotic cleaning systems. The SWOT concerning robotic cleaning technology in hotels and PESTEL to consider the external influence of this technology. The first advantage of using robotic cleaning systems is that its functionality and cost are much higher than fully automated systems.

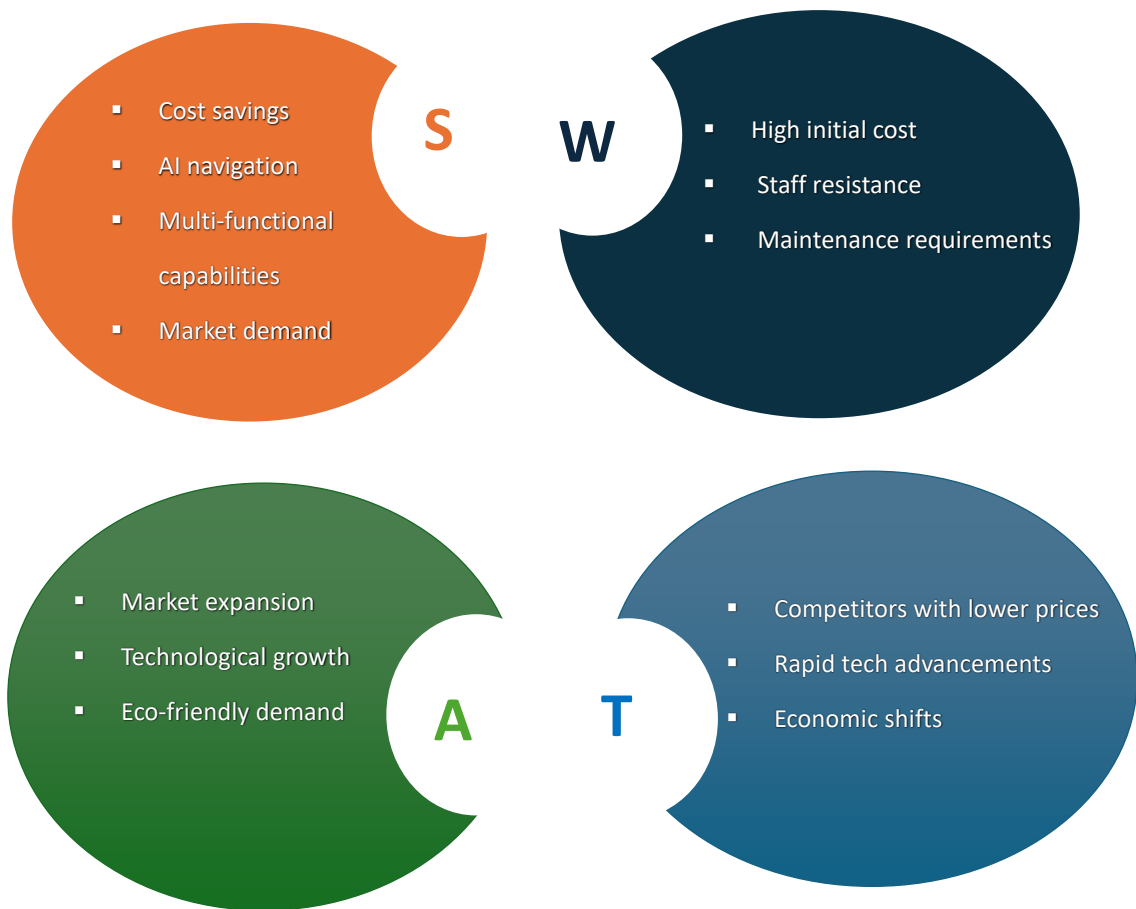


Figure 9. SWOT Analysis

SWOT Analysis:

Strength: The basic proposed robotic cleaning system costs €20,000 and comes with advanced features, including the use of intelligent navigation, multiple-function cleaning, increased data protection.

Efficiency: The high degree of operations efficiency, minimum cost and expenses for labor force and constant effective function in cleaning.

Market Demand: Demanding environment created by modern business needs as the number of hotels looking for ways to improve the quality of service and minimize expenses.

Weakness: This is likely to be resistance from the Cleaning staff, who may have to deal with the robotic systems and also guests who may have negative attitudes towards the robotic systems.

High Initial Investment: This robotic system cost a lot of money initially to anyone interested in using it and this is a major set back for the smaller hotels.

Maintenance Requirements: Specialized technology may need special care and may possibly be expensive in the long run as compared to simple technology.

Opportunities: Concern for sustainability triggers the need for employing environmental planetary robotic robots within the hospitality industry. Continuing trends of automation in different industries are propositions for expansion of Ir system's application in hotels and others. The nature of these technologies as being developmental means that there are constant improvements in terms of efficiency and costs.

Threats: Professionals in the economies of the world may cause apprehensive attacks on the pocket of the hotel leads to the cutting down of investing in the new technologies. Other examples of competitive models include Zerodis at \$20, NOESIS at \$1,599 with possibilities for lolr price choices mostly attracting buyers who are keen on a reasonable price. High rate of change of new technologies may pose a big challenge to Ir system since this area may gain relevance in the market very fast and then loses that relevance if not updated.

PESTEL Analysis

Political: There are some measures taken by the government, which impacts the robotic systems, which can be adopted for the functioning of hotels, it has to do with issues of labor, automation and safety. To support them for government subsidies however, some hotels may be pressured to adopt robotic cleaning solutions which are more ecological.

Economic: The overall macroeconomic environment and the relative upward trajectory within the hotel business will define the automation demand. What this means is that when costs of labor rises, the investment in robotic cleaning systems could be manageable for hotel managers in terms of cost.

Social: Customer standards of hygiene and general efficiency standards developed prior to its adoption have been adjusted in hotels learning from the use of technology. Automated process enhancement must probably call for training for both the conventional employment and the new robotic employment.

Technological: Advancements in AI, machine learning and sensor enhance capability and affordability of robotic systems. It will integrate with other systems that deal with management of services in hotels that would optimally offer customer value.

Environmental: The increasing pressure for extensive environmental conservation in hospitality results in the incorporation of the cleaner and technological practices. After Covid 19, concentration of hygiene cleaning increases dramatically. Many advanced robots can also assist in hotel sustainability and decreasing the energy costs on behalf of the hotels.

Legal: Total legal risks that may be embraced by automation engaged in an accident or erroneous operational cleaning services may need a sketchy or liability.

Thus, there is a need for evaluating the possibilities and further consequences of robotic cleaning systems with the help of both the micro (SWOT) and macro (PESTEL) analysis. The case analysis presented in this paper provides hotels with a structured approach in evaluating robotic cleaning technologies by comparing internal strategic capabilities and external drivers with threats and opportunities in the macro environment.

4.6 Case Study

The case study will assess the potential economic benefits and costs, productivity, and customers' satisfaction resulting from the use of this technology in the hospitality industry. This case offers insights into further cleaning development in hotels by elaborating on the costs, benefits and possible difficulties of employing robotic systems. Cost Reduction: To reduce the quantity of labor cost incurred in the house keeping operations. Efficiency Improvement: For promotion efficiency and standardization of cleaning services delivered at the hotel. Customer Satisfaction: To increase guest satisfaction with recommendations of superior cleanliness standards. Data Security: To meet the legal requirements of data protections laws while employing robotic systems.

4.6.1 Selection of Automation System

Based on the research carried out and subsequent assessment, the system has been applied and selected because of the special functions such as artificial intelligence, which allows the robot to find its way around the facility, and also Intelligent multi-task cleaning including vacuuming, mopping and sanitizing as well as compatibility with ho-tel management software. The plan to introduce automation into practice was initiated with the testing in common public areas such as the lobby and corridor systems. Therefore, users and guests will be asked for feedback on the robot-cleaning system and the staff will be trained on how to operate and maintain the robots during implementation. Data analysis and economic outcometion, the hotel management decided to invest in a state-of-the-art robotic cleaning system priced at €20,000. This system was chosen for its advanced features, including AI-driven navigation, multi-

functional cleaning capabilities (vacuuming, mopping, and sanitizing), and seamless integration with ho-tel management software.

4.6.2 Data Analysis and Economic Outcome

The company carried out a benefit-cost analysis to assess the economic opportunities of the robotic system: The performance and efficiency of the robotic cleaning systems evaluates based on the some evaluation methods. However, to clean each section, decreased employee time spent cleaning and the guest satisfaction scores before and after the switch. The process encounters some difficulties; the first one is that, some of the staff members are against investing in such technology fearing they may lose their jobs to it. Still, this risk is countered by the management by helping the employees understand that the robots introduced to the companies will be meant to augment human work. Moreover, minor technical problems regarded the navigation and the schedule could bring problems, but all of them will be solved with software upgrades and constant vendor's help. One major reminder from this pilot is the need to train the staff on what the robots can do in addition to educating them about the service. The idea that many employers are universally accepting because the employees are trained to become more comfortable with the new technology during hand.

In comparing and contrasting the two, the assessment shows that the integration of the robotic cleaning systems greatly enhances operational performance efficiency. Cleaning times are cut down by 30 percentages in its areas of application, and the entire labor cost is cut down to €2000 every month, which is a great amount of saving. These impressions suggest that the essence of services has slightly improved – for many guests, the fact that automation manages to produce reasonably clean space is enough. Employees enjoy these robots because they are able to avoid handling repetitive work, which they said has made them have more morale while working. Robotic cleaning has clean economic benefits at Original Sokos Hotel and enhanced the operational efficiency. This automatically relieves the hotel's labor cost while at the same time enhancing the guests' experience thus meaning that the hotel can adopt advanced technology to enhance guests' experiences. Based on the experiences of the Mills, this paper

showcases the possible benefits of investing in robotic solutions to drive increased efficiency for hotels and help other similar businesses considering the application of robots. Hotels should go on engaging staff to develop the understanding of new technological trends and to work in cooperation with new robots, monitoring robotic cleaning system efficiency and searching for the ways to improve it, and examine automation prospects in other spheres, including laundry and maintenance, in order to escalate general productivity.

4.6.3 Transformation Timeline

It should define the major goals which, in fact, should be already set at this stage, as well as the tasks that may be solved without time-consuming at best – it will take about from 0 to 6 months approximately.

Pilot Testing: The first is a pilot stage at which the robotic cleaning system is introduced in several areas of the hotel that include lobbies and public washrooms. According to the research, such a phase usually lasts between a one and three months.

Training and Adjustment: The training of the staff for the operation of the robots as well as changing organizational operations may take an additional 1-2 months to establish the preliminary response and the reengineering process.

Expansion to Other Areas: Once the trial run showcase success, the application of the robotic system can be extended to guest room cleaning and other functional areas in another 3 – 6 months.

Ongoing Support and Maintenance: In this phase maintenances checks and updates to the software will be required to ensure that these will run most optimally and where there are any technical issues encountered.

Process Optimization: After full implementation, the hotel may then focus on enhancing the efficiency of cleaning with the robots by analysing the robots data (for instance, pattern of cleaning, usage rate at a particular period).

Full Adaptation: Within the 12-24 months of the establishment of the identified technology, hotel industry companies can apply robotic cleaning systems, and the hotel employees can easily learn how to work with them.

Further Automation Opportunities: The hotel may seek other forms of automation in other areas for instance in doing laundry or in the maintenance section since the study showed a positive result has been realized by.

Technology Reliability: It is the degree of efficiency and reliability that the IL precursor robotic cleaning system seems to reach. An organisation that will ensure systems are performing optimally at all times will ensure that capital is reinvested into automation systems.

Market Demand: It also means that pressure on hotel corporations to bring out robotic possibilities as soon as possible could be up, and this helps amplify the change.

Financial Considerations: Forecast is that the rate of change will be deepest in the sector with high potential ROI and cost savings when utilizing the robotic system. If a lot of money can be saved within the first few months of operation, chances are the hotel will be enticed to automate more.

To sum up, a clear compliance to rules on the protection of data and safety of individuals will determine the extent to which the robotic technologies can be deployed in the management of the hotel facilities. However, strength of receiving consistent feedback from the staff and guests at the hotel will be useful in increasing the efficiency of the robotic systems in delivery of quality services to the various customers.

5 Conclusion

This thesis concludes the successful adoption of robotic cleaning systems into the hospitality industry and the efficiency benefits that such advanced technologies present to contemporary hotel operations. Consequently, this study supports the proposition that automation is a viable, cost-effective solution, applicable in the Original Sokos Hotel that creates guest satisfaction while effecting labour cost savings with enforced high cleanliness standards. The numerical evaluation establishes that the implementation of the robotic system guarantees a rapid payback period to recover investment, and a high NPV confirmed the long-term economic benefits of utilizing automation.

5.1 Addressing the Problem Statement

The positive effect realized on operating functions does not end with cost reduction. Robotic cleaners that operate continuously make it possible always to meet agreed cleanliness by standards, which, especially in the hospitality industry where client satisfaction depends on the neatness of the environment in which they book. The first of these is rationalized by the robots' capacity for working longer hours, especially during periods of pre-c crowding, and increases in positive guest comments on hotel room cleanliness.

1. How does the implementation of robotic cleaning systems in the hospitality industry improve cost-effectiveness and lead to better economic outcomes?

When examining the application of robotic cleaning systems at the Central Business District especially the Original Sokos Hotel, it emerged that the cost benefit analysis was rather high through the fact that the cost of labor had been considerably cut. For instance, investing in a €20 000 robotic cleaning system to eliminate human personnel cleaning the hotel hallways ensure that the hotel break even is made within 7 months. The total monthly cost of the robot is somewhat €334, thus the robot provides a monthly saving of €9,666 since manpower cost is €10,000. In addition to these, this investment

pays for its cost very early and or positively impacts other long-term financial consequences of the hotel by enhancing efficiency, resource productivity, and freeing up resources to be employed on higher added value activities that increase overall profitability.

2. How do scenario analyses of existing and low-cost robots influence KPO's decisions on operational efficiency and environmental sustainability?

The scenarios established in the study suggest that the application of low expensive servicing robotics solutions would provide (KPO) a new efficient working platform and CA-mitigation advantages. For instance, these robots save energy and water in comparison with conventional methods of cleaning services. A reduction in the use of these resources is beneficial from the viewpoint of sustainability, which is on KPO's agenda, and is evidence of how robotics enable positive environmental activities. Moreover, by studying several robotic modes (manual, semi-automatic, automatic), KPO can make correct choices in choosing the optimal path in their work and remain committed to the concept of sustainability.

5.2 Theoretical Contribution

This research extends existing theory on automation in the context of the hospitality industry and from an operations and cost perspective. This proprietary work builds on a number of steps that have been derived from cost-benefit analysis approach, scenario analysis, and Net Present Value (NPV) analysis to set a technique to measure and compare the organizational benefits and costs of adopting robotic cleaning systems. The results provide evidence to the existing theories about automation and its effect on labour cost reduction, inclusive of automation of services with improved quality and proficiency and this include automation in line with sustainable development. However, it is necessary to pay much attention to the ecological factor related to the usage of robotic cleaning systems. This study shows that these technologies are useful in achieving a better and more efficient operational model through a reduced use of both

water and chemical than is normally used in the manual methods of cleaning. This is done in line with the current trend within the industry that have seen buyers demand for environmental conscious practices. A concern with the environment is further demonstrated by the fact that robotic cleaning consumes fewer resources hence being evidence that a hotel can be profitable and at the same time sustainable. Also, this research goes further than existing literature to establish precise break-even points and NPV towards robotic automation to offer a framework for future research concerning automation in industries with high cost-driving factors.

5.3 Practical Contribution

Most executives would agree that the implementation process is for the most part successful; however, it has not been without its difficulties. The major threat at the beginning was staff resistance whereby the workers were likely to be replaced by the robotic systems. Yet, the decision made by the management to embrace key messages which were meant to explain to the employees that robots are here to support, not replace them worked. The elimination of fear was done by continuing the training of all the staff members as well as creating additional open communication channels which made the staff more comfortable to work together with the robots. Its argument underscores the primary focus of change management when adopting technology at the workplace and underscores training of employees as a key cornerstone for the automation processes. In terms of practical application, this thesis provides guidelines for hotel managers, the actors of the hospitality industry and other decision makers. The results highlighted that use of robotic cleaning systems gained relatively quick returns on investments within seven months along with higher reduction in monthly cost and thirty five years' payback period with NPV of € 106,761.58. The application of robotic automation has benefits for businesses such as the Original Sokos Hotel and other similar institutions in the sense that it lowers operational expenses while nurturing the quality of service, as well as prevention of usage of natural resources. The present study gives solid evidence for the hotel managers to decide upon the automation technologies that highlight that such systems can ensure high cleanliness standards, better resource

management, and new expectations of the customers at the same time at reasonable costs.

5.4 Future Work

This study is confined to robotic cleaning systems but future research could elaborate these findings by investigating automation in other functional specialisations within hospitality such as laundry services, food production, or front of house operations. Also, more empirical research may be conducted on the consequences of automation on employees' tasks and competencies, and change management over the longer term. It would enrich the understanding of the effects of automation if in addition to the effects of changing the KPI to a new pricing model the authors considered other possible pricing models, maintenance issues, and scaling factors related to the size of the hotel and regions of the world. Finally, if applied on the current state of the hotel management software with the technological future of applied AI-lead robotics for prognostic maintenance and individual guests services, insights can be obtained for the next stages of the industries development.

The conclusion of this thesis aims to summarise the critical consequences of implementing robotic cleaning system within hospitality industry focusing on Original Sokos Hotel. This study proves that allowing the use of automation in the cleaning activities provide substantial financial benefits and efficiency in production, thus improving the guests' experience. The analysis reveals a compelling narrative: robotic cleaning system shows that it is a good financial investment as a first capital investment of € 20,000 after which the system pays for itself quickly as it takes seven months to break-even. Such investment is thus long-term profitable as evidenced by the fact that this level of investment has a NPV of € 106,761.58 and this is achieved swiftly. The financial that may be achieved are, however, a relatively small part of the multiple opportunities which robotic systems provide. It is in the light of this research that the authors explain how it brings about a drastic cut in the time by 30 percent with the implication that members of staff can refocus their energies and skills on functions that

can create more tangible value for the guest. Taking into account that such hotels have to earn extra money to support the increased labor costs which may considerably reduce their margins, the robotic system shows potential for saving about €2,000 per month, which allows maintaining high service standards while minimizing the costs.

Therefore, this thesis offers an insightful analysis of the protentional of robotic cleaning systems to impact the hospitality industry positively for change. Staying true to its name and practical applicability, the best example can be set by looking at how such systems were implemented at the Original Sokos Hotel which this paper seeks to export to other hotels who are considering the adoption of new technologies. The results call for the reconsideration of conventional cleaning approaches and highlight the necessity for the industry's increase in the use of automation technologies, which means a shift toward a future in which the hotel industry can reach operational efficiency, economical profitability, and guest satisfaction improvement through the application of advanced solutions. With the ever emergent hospitality industry, this research paves way for further studies into the use of automation and automation in the other functional areas of operation other than cleaning. Further research could consider other application scenarios in washing services, cleaning and other additional services, which would allow broadening the possibilities of increasing efficiency and customer satisfaction in the sphere. These insights about the subjects of interest reflect the slow and iterative change constant in the hotel business due to the constant advancement of technology in the marketplace. In conclusion, the present work demonstrates the spectacular ability of robotic cleaning systems in increasing both the economic and operational performance and underlines their crucial mission to revolutionize the hospitality industry and meet the new requirements of contemporary consumers.

References

- Abraham F., Bormans Y., Konings J. (2024). Price-Cost Margins, Fixed Costs and Excess Profits. *The Economic Journal*. doi:doi.org/10.1093/ej/ueae037
- Bagadiya D., & Kathiriya K. (2024). *The Future of Hotel (A Symbiosis of Automation and Human Interaction)*. Noudettu osoitteesta <http://www.theseus.fi/handle/10024/861876>
- Banala, & S. (2024). The Future of IT Operations: Harnessing Cloud Automation for Enhanced Efficiency and The Role of Generative AI Operational Excellence. *International Journal of Machine Learning and Artificial Intelligence*, 1-15. Noudettu osoitteesta <https://ijmlai.in/index.php/ijmlai/article/view/42>
- Barbara, Adamo, D., Gastaldi, & Nizami. (2024). Clean energy for a sustainable future: Analysis of a PV system and LED bulbs in a hotel. *Energy*. doi:https://doi.org/10.1016/j.energy.2024.131547
- Borghi, M., Mariani, M., Vega, P., R., J. (2023). University of Reading, National University of Singapore. *Psychology and Marketing*. doi:10.1002/mar.21903
- Buhalis, D. (1998). Strategic Use of Information Technologies in the Tourism Industry. *Tourism Management*. doi:https://doi.org/10.1016/S0261-5177(98)00038-7
- Cain, Mistry, Douglas, Rahman, & Moreo. (2024). Luxury hotel technology trends: a multi-generational analysis. *International Journal of Contemporary Hospitality Management*. doi:https://doi.org/10.1108/IJCHM-10-2023-1597
- Chambers, & D.M. (2024). Net Present Value Calculations for Mining Post-Closure Financial Assurance. *Mine Water and the Environment*. doi:https://doi.org/10.1007/s10230-024-00995-1
- Chatterjee, Rana, & Dwivedi. (2024). How does business analytics contribute to organisational performance and business value? A resource-based view. *Information Technology & People*. doi:https://doi.org/10.1108/ITP-08-2020-0603
- Fatih, E. (2019). *Smart tourism technologies: applications in hotel business*. Theory and Practice in Social Sciences. 74

- Ismanov, I., Qayumov, N., Mukhamadjonova, D., B. (2024). AI and Cost Management: Strategies for Reducing Expenses and Improving Profit Margins in Business. Chikkaballapur, India: IEEE. doi:10.1109/ICKECS61492.2024.10616761
- Ivanov, S., & Webster, C. (2024). Automated Decision-Making: Hoteliers' Perceptions. *Technology in Society*. doi:https://doi.org/10.1016/j.techsoc.2023.102430
- Jasonos, M., & McCormick, R. (2017). *Technology Integration for Restaurants & Hospitality Industry in the Year 2025*. Haaga-Helia University of Applied Sciences. Noudettu osoitteesta https://urn.fi/URN:NBN:fi:amk-2017072914193
- Jones, T. (2007). *Professional Management of Housekeeping Operations*. John Wiley & Sons.
- Kahraman, C., Haktanir, & E. (2024). *Fuzzy Break-Even Analysis*. Cham: Springer Nature Switzerland. doi:https://doi.org/10.1007/978-3-031-54660-0_8
- Kanaskar, A., A., Kamble, V., Bhamkar, T., S. (2024). Design and Fabrication of Dishwasher for Hostel Students. *International Journal of Advanced Innovative Technology in Engineering*. doi:10.5281/zenodo.12163584
- Khanh, N. H., & Phan, A. C. (2024). Determinants for Labour Productivity Improvement in Hotel Service: Empirical Evidence from Vietnam. *International Journal of Productivity and Quality Management*. doi:https://doi.org/10.1504/IJPQM.2024.136190
- Kosta, O. (2024). The SERVQUAL Method as a Tool for Investigating the Quality of Cleaning Services. *An International Serial Publication for Theory and Practice of Management Science*, (ss. 113-130). Bor, Republic of Serbia.
- Kröger, & F. (2024). *From Automated to Autonomous Driving* (1 p.). Springer Cham. doi:doi.org/10.1007/978-3-031-49881-7
- Lee, & E. (2024). Exploring the Consequences of Automation in the Post-Pandemic Era: Hotel Labor Woes. Emerald. doi:https://doi.org/10.1108/WHATT-09-2024-0215
- Lee, C. C. (2024). Will Artificial Intelligence Make Energy Cleaner? Evidence of Nonlinearity. *Applied Energy*. doi:https://doi.org/10.1016/j.apenergy.2024.123081 75

- Liu,Gu,& Liao. (2024). Operation design of a robot logistics system considering demand fluctuations in the hotel industry. *International Journal of Contemporary Hospitality Management*. doi:<https://doi.org/10.1108/IJCHM-08-2022-0968>
- Mitra. (2023). Currency conundrum: unravelling the impact of exchange rates on Nordic hotel pricing, occupancy, and revenue in Finland, Norway, and Sweden. *Scandinavian Journal of Hospitality and Tourism*. doi:<https://doi.org/10.1080/15022>
- Moreno, B.,Yahaira, L.,Ban,Hyun-Jeong,& Kim, H.-S. (June 2024). Enhancing the Maintenance Practice to Improve Guests' Satisfaction in the Hotels Industry. *Journal of Hospitality and Tourism Insights*, 18-29. doi:<https://doi.org/10.1108/JHTI-09-2022-0467>
- Musekiwa, C.,Muunga, P.,& Kabote, F. (2024). Artificial Intelligence and Design of the Future - Some Serious Deep Thoughts. *Dspace*. Noudettu osoitteesta <http://10.0.100.40:8080/xmlui/handle/123456789/2635>
- Nikolskaya, E.,Lepeshkin, V.,Kulgachev, I.,Matveev, A.,& Lebedeva, O. (2020). Perfection of Quality Management of Hotel Services. *Journal of Environmental Management and Tourism*, 417-421. doi:10.14505//jemt.11.2(42).20
- Noorjahan,S.,Basha, S.,& S. (2024). Developing an intuitionistic fuzzy rough new correlation coefficient approach for enhancing robotic vacuum cleaner. *Science Progress*. doi:[doi:doi.org/10.1177/003685042412754](https://doi.org/10.1177/003685042412754)
- Ostrowska,& Pawlikowska. (2022). Tourism, the hotel industry at the time of the COVID-19 pandemic. *Central and European Online Library*. Noudettu osoitteesta <https://www.ceeol.com/search/article-detail?id=1161239>
- Parekh,& R. (2024). Automating the design process for smart building technologies. *World Journal of Advanced Research and Reviews*.
- Pillai, S. G.,Haldorai, K.,Seo, W. S.,& Kim, W. G. (2021). COVID-19 and hospitality 5.0: Redefining hospitality operations. *International Journal of Hospitality Management*. doi:<https://doi.org/10.1016/j.ijhm.2021.102869> 76

- Polonara, M., Romagnoli, A., Biancini, G., L. (2024). Introduction of Collaborative Automation in the Production of Automotive Parts: A Case Study. *Machines*. doi:<https://doi.org/10.3390/machines12030196>
- Ran, L., Wang, K., Sun, J., Y. (2024). Can digital technology remove impediments in the dual circulation?—An enterprise cycle efficiency perspective. *Managerial and Decision Economics*. doi:doi.org/10.1002/mde.4079
- S Group. (2023). *S Group's sales grew early in the year driven by hotels and restaurants together with grocery trade, which developed stronger than the market*. Helsinki: SOK Corporation. Noudettu osoitteesta <https://www.s-ryhma.fi/en/news-item/s-groups-sales-grew-early-in-the-year>
- Saarinen, J., & Lundén, A. (2024). Tourism and Tourists in Nature: Governance of National Parks and Wilderness in an Era of Global Change. Teoksessa J. Saarinen, & A. Lundén, *The Wiley Blackwell Companion to Tourism* (ss. 563-576). Hoboken: Wiley Blackwell. doi:<https://doi.org/10.1002/9781119753797.ch38>
- Salmona, M., Kaczynski, & D. (2024). Qualitative data analysis strategies. doi:doi.org/10.4337/9781803927008.00012
- Shukla, Tripathi, Bharti, Parashar, Bhardwaj, Gupta, & Verma. (2024). *Modern Approaches and Implications Toward Industry 4.0*. (Kumar, Jain, Ibarra, Talib, & Kukreja, Toim.) doi:<https://doi.org/10.1002/9781394242641.ch8>
- Skachkov, N. (2024). *Robotization in Hotels: Hotel Guests' Attitudes Towards the Use of Robots in Hotel Services*. Noudettu osoitteesta <https://urn.fi/URN:NBN:fi:amk-202404298194>
- Svanberg, M., Li, W., Fleming, M., N. (2024). *Beyond AI Exposure: Which Tasks are Cost-Effective to Automate with Computer Vision?* SSRN. Noudettu osoitteesta <https://ssrn.com/abstract=4700751>
- Timonen, K. (2024). *Responsibility of Hotels in Tornio*. Tornio. Noudettu osoitteesta <https://urn.fi/URN:NBN:fi>
- Waris, I., Mohd Suki, N., Ahmed, A., & Barkat, W. (2024). Environmental corporate social responsibility initiatives and green customer citizenship behavior in tourism industry: the mediating roles of green trust, customer-company identification 77

- and green corporate image. *Social Responsibility Journal*, 1138-1156. doi:<https://doi.org/10.1108/SRJ-07-2023-0378>
- Yang, Y., Lin, M. S., & Magnini, V. P. (2024). Do guests care more about hotel cleanliness during COVID-19? Understanding factors associated with cleanliness importance of hotel guests. *International Journal of Contemporary Hospitality Management*. doi:<https://doi.org/10.1108/IJCHM-08-2022-0956>
- Yang, Y., Lin, S., M., Magnini, & P., V. (2024). Do guests care more about hotel cleanliness during COVID-19? Understanding factors associated with cleanliness importance of hotel guests. *International Journal of Contemporary Hospitality Management*, 239-258. doi:<https://doi.org/10.1108/IJCHM-08-2022-0956>
- Yaşar, E., Öztürk, & İ. (June 30, 2024). Causes and Consequences of the Fears Experienced by Employees in Hotel Businesses. *International Journal of Contemporary Tourism Research*, 41-49. doi:<https://doi.org/10.30625/ijctr.1453115>
- Zaland, A., Saad, S., Rasheed, K., S. (2024). *Automation in Construction Industry*. CRC Press.
- Zijl, v., & R. (2024). Adopting CATs: Development of Cleaner Assisting Technologies for a Gradual Technology Adoption and Implementation Process in the Cleaning Sector.
- Sharma, M., Tyagi, P. K., Semwal, R., P. T., Singh, V. J., & Nisha, K. (2024). Robotic Concierges and Smart Spaces: A Vision for the Future of Hospitality Services. *Atlantis Press*. doi:10.2991/978-94-6463-437-2_34
- Victor, G., & Aguilar-Escobar. (2021). Hotel room cleaning: Time study and : Time study and analysis of influential variables in a Spanish hotel. *Journal of Industrial Engineering and Management*. doi: <https://doi.org/10.3926/jiem.3441>
- Hussain. (2016). Outsourcing Housekeeping: An insight into two cleaning companies, SOL and N-Clean, in Helsinki. *THESUS*. doi:<https://urn.fi/URN:NBN:fi:amk-2016053010696>
- Das, P., Dandu, M. S., Rath, M. A., & Das, M. M. (2024). Progressive Approach of Cleaning Validation in Pharma Companies. . *African Journal of Biomedical Research*.

Appendices

Appendix 1. Data Collection for BEN and NPV

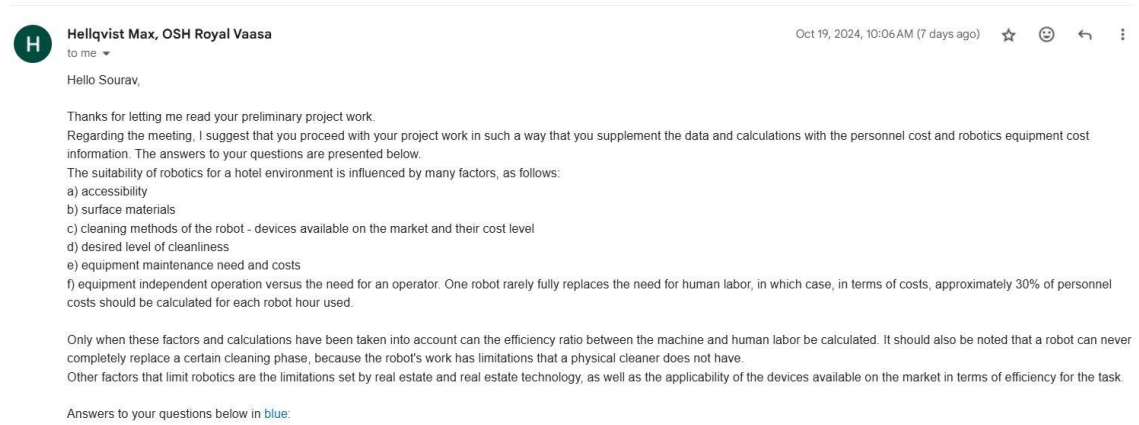


Figure 10. First Interview with Sokos Manager



Hellqvist Max, OSH Royal Vaasa
to me ▾

Figure 11. First data collection from hotel

Budget for Robotic Cleaning Systems: What is the **maximum** amount your hotel would consider investing in a robotic cleaning system?

The budget depends on the efficiency to be achieved. Since there is no previous experience with the technology and its functionality in our hotel environment, the initial investment would be around €10,000 as a test. In the future, as an individual hotel, we are ready to invest a **maximum** of €50,000 if efficiency is achieved.

Labor Replacement: How many cleaning staff members do you envision replacing with the robotic system, and would they be fully replaced or reallocated to other tasks?

A cleaning robot designed for cleaning public spaces would replace the work input of one employee. When premises are cleaned daily in two shifts, the hourly savings would amount to approx. 10 hours/day.

Salary of Workers: What is the current average salary of cleaning staff members? This will help assess potential labor cost savings.

The salary of a hotel cleaner belongs to category 2 of the collective agreement and constitutes costs for the employer, including employer fees, on average €19/hour.

Maintenance Budget: How much does the hotel currently allocate for the maintenance of cleaning equipment and systems?

On an annual basis, cleaning supplies are renewed or purchased worth approx. €10,000.

Complete your work with costs and calculations, and after completing these, send the work to me for review. The goal is to make readings reliable and believable.

With Best Regards



Figure 12. Budget Calculation Data Collection

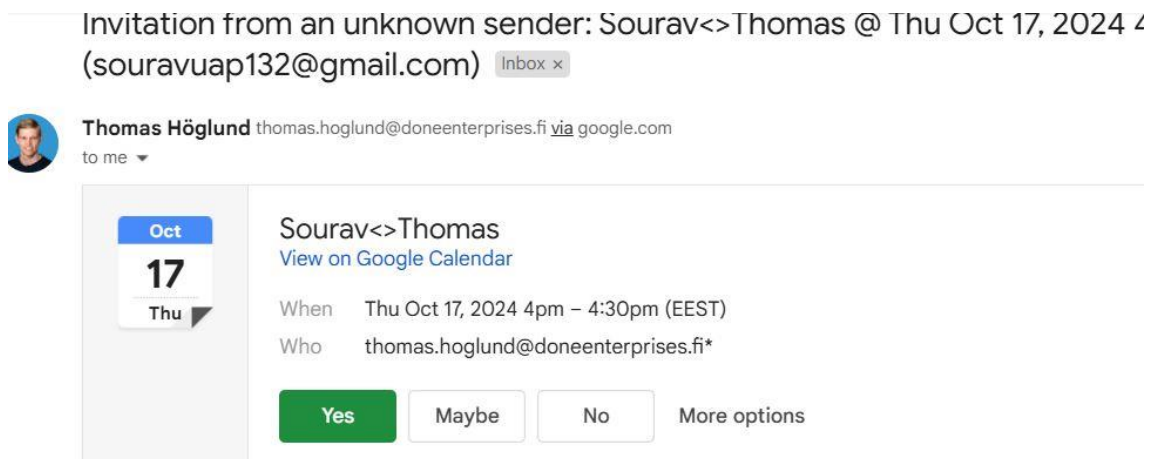


Figure 13. Meeting with Done Robotics

Invitation from an unknown sender: Sourav Mukharjee and Thomas Höglund @ Fri Sep 6, 2024 10am - 10:30am (EEST) (souravuap132@gmail.com) [Inbox x](#)

Thomas Höglund thomas.hoglund@doneenterprises.fi via [google.com](#)
to me ▾ Tue, Sep 3, 11:27 AM ☆ ☺

This event isn't in your calendar yet. You haven't interacted with thomas.hoglund@doneenterprises.fi before. Do you want to automatically add this and future invitations to your calendar?

[Add to calendar](#) [Report spam](#)


	<p>Sourav Mukharjee and Thomas Höglund View on Google Calendar</p> <p>When: Fri Sep 6, 2024 10am - 10:30am (EEST) Where: Google Meet (instructions in description) Who: thomas.hoglund@doneenterprises.fi*</p>	<p>Agenda Fri Sep 6, 2024</p> <p><i>No earlier events</i></p> <p>9:26am thomas meeting</p> <p><i>No later events</i></p>
---	--	--

Figure 14. Structure Analysis with Done Robotics