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Robot Authority in Human-Robot Interaction: The Role of Contextual Settings in a Conflict Scenario

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Abstract

The concept of robot authority challenges the traditional authority associated with human traits. It raises safety concerns when people interact with an authoritative robot. Previous research has focused on perceived robot authority and human compliance, largely inspired by the Milgram study, yet the impact of contextual settings remains unexplored. This study addresses this gap by investigating how different contextual settings —public, private and professional— affect perceptions of a robot's authority during conflict scenarios. The robot employs consistent authoritative behaviour across all contexts through commands sentence accompanied by justifications of action. This video-based study is taken from the first person perspective. To measure robot perceived authority and people's compliance, Likert scales and open questions were used in the online questionnaire as subjective measurement. The conflict scenario presented is the goal conflict in which the robot and the human share time and space that will influence the outcome of the goal. The findings indicate that robots exhibit a low degree of authority, which is insufficient to significantly alter human compliance. These results underscore that contextual factors have little effect in influencing perceived robot authority during the conflict scenario.

Keywords: Robot authority, Contextual settings, Conflict scenario, Compliance, Human-Robot interaction, HRI,

Chapter 1

Introduction

The idea of robots having authority is unconventional and has raised significant safety concerns among people when interacting with robots in authoritative roles [1]. These concerns are often heightened by narratives that depict robots as potentially uncontrollable beings that might rebel against humans [2]. Despite scepticism towards robot authority, research has shown that authoritative robots can have several benefits. For example, they can influence human actions by guiding people to safety during emergencies and motivating individuals to perform better in work and educational settings [3] [4] [5] [6].

Most studies on robot authority have focused on understanding the effects of robot authority by measuring compliance and obedience [3] [4] [6]. However, the factors that influence people's compliance and obedience towards robots are not well understood. Previous research has mainly looked at the role of robots and the type of authority they possess, often inspired by the Milgram study on authority [7]. The impact of contextual factors has often been overlooked or considered a secondary finding in these studies. However, based on previous studies, factors such as location, in this experiment known as *contextual settings*, can significantly influence interactions, such as trust [8] [9], cooperation [10] [11], and perception of interaction [12] [13] [14]. Despite these findings, the specific effects of different contextual settings on the perception of robot authority remain underexplored. This raises a question about the relation between contextual settings and the perception of authority of the robot.

Interactions between humans and robots are prone to conflict, particularly as autonomous robots become an integral part of daily life [13] [15]. Conflicts can arise in various settings, including private, public, and professional settings. These conflicts often emerge because robots and humans share spaces [16], pursue different goals [13], and opposed expectations of the interaction [17]. In this study, a conflict scenario is used to initiate interactions. Conflict also can help highlight authority by influencing decision-making through power dynamics [18].

The research question that emerged from the findings is the following: **How do contextual settings influence the perception of a robot's authority during a conflict scenario?**

This research aims to investigate how different contextual settings affect the perceptions of robot authority in conflict scenarios. It will help to make the robot more effective in autonomous work by resolving conflicts that require quick decisions in various settings. This research also aims to prove that human compliance and obedience toward the robot is influenced by the location where interaction occurs.

To answer the research question, the study is conducted online using a video-based approach. Participants are shown videos in which they encounter robots in conflict scenarios. After viewing each video, participants complete an online questionnaire that includes both scale-based questions to measure specific perception and open-ended questions to capture more detailed reasoning. Participants are recruited online through social media and group chats. The study employs a within-subject design, with all participants watching each video in random order to control for individual differences. The data will be analysed using a combination of quantitative methods for scale-based responses and thematic analysis to identify patterns in open-ended responses, providing a comprehensive understanding of participants' perceptions of robot authority in conflict scenarios.

The following sections will cover the theoretical framework, including an exploration of robot authority in HRI, authority in various contextual settings, the benefits of robot authority, methods for measuring authority, and an overview of conflict scenarios. The problem statement will explain the hypotheses of the research. The methodology section will address study design, survey procedures, and animation scenarios. This will be followed by an analysis of the results and, finally, a discussion and conclusion.

Chapter 2

Literature Review

2.1 Defining Authority in HRI

A fundamental understanding of how authority is conceptualised within Human-Robot Interaction (HRI) is essential for further exploration of this topic. Since there are diverse perspectives in HRI about authority, this review aims to inspect and clarify the concept of authority as it has been defined in prior HRI research through a comprehensive examination of several researchers' perspectives. This approach is to ensure a theoretical foundation and manage expectations of the definition of authority in HRI.

One notable study, conducted by Cormier et al., investigated authority in HRI by observing how people obey robots. In their experiment, the robot was placed as a legitimate authority figure, comparable to the level of authority in the Milgram experiment [7]. A figure of legitimate authority is perceived to have the rightful claim to power and control over others [19].

Another perspective on authority in HRI is offered by Saunderson et al., who applied Aghion's formal and real authority theory to their experiments examining the influence of robot authority in workplace settings [20]. Formal authority derives from social roles and the implied power of decision making, as seen in roles such as managers and security guards. Real authority comes from explicit control over decision making, such as setting rules or assigning tasks, often reinforced by monetary incentives [21].

In the context of human-robot teaming, Haring et al. explored the concept of delegated authority, using Baker's definition, which describes it as the informal authority a superior grants to a subordinate [6]. In their study, robots were assigned coaching roles, highlighting the delegation of authority within teams. The authority role is given to the robot by a human authority figure.

2.2 Robot Authority's Impact in HRI

The importance of authority in HRI is supported by many studies showing the benefits of giving robots authoritative roles. For example, Cormier et al. have demonstrated that even small humanoid robots can have enough authority to influence human behaviours, indicating that robots can significantly affect human actions [3]. Agrawal et al. further show that robots can guide people to specific exit routes in emergencies, proving that robots can alter human decision making in critical situations [4]. These findings highlight the potential for robots to play key roles in the direction of human actions in various scenarios.

Additionally, Maggi et al. have found that robots can improve human performance on tasks by giving motivational commands when they have authority. This means that robots can effectively encourage people to perform better, making them useful in settings where high performance is needed, such as workplaces and schools [5]. The ability of robots to motivate humans suggests that they can be valuable tools to increase productivity and efficiency.

Haring et al. also compared the effectiveness of robots with human coaches, finding that robots can have a similar influence on people, although the degree of influence is less than the human coach. This supports the idea that robots can take on coaching and instructional roles, showing that they can be as effective as human coaches in training and educational contexts [6]. Together, these studies show the significant impact that authoritative roles can have on HRI, demonstrating how robots can effectively guide and improve human behaviour and performance.

2.3 Robot Authority in Various Contextual Setting

2.3.1 Defining Contextual Setting

The meaning of context in the empirical study can be understood as another term for all the intervening variables. Context covering aspects such as settings (whether it is private, public or in a particular place), time of day (for instance, the busy morning hours versus a quiet evening) and the individuals involved (including their personalities, roles and relationships) [22]. Context plays a crucial role because it gives meaning to the interaction [23].

Research findings indicate that context, specifically whether HRI occurs in a private or public setting, significantly affects the degree to which social norms and personal interactions are integrated. In private settings, where the interaction is between an individual and a robot, obedience to social norms may be less followed than in settings where technology is used by groups of people [10] [13]. A similar case of public and private context occurs with the deployment of security robot. In the public area, the security robot gives people a sense of security, yet in the private area, the security robot is perceived as a surveillance device beneficial to the hidden agenda [14].

Acceptance and willingness to cooperate with robots in the production environment was higher than in the care environment and education [11] [12]. In the care setting where an intimation is needed, the robot is also expected to behave more human or have an anthropomorphic feature to earn greater cooperation [24]. People also perceive care as something exclusive to humans, and anthropomorphism tends to increase trust and cooperation with robots in ambivalent care settings. In this context, educational settings involving children are also viewed as care settings.

Ethnographic research on robot deployment in hospital departments has highlighted the significant impact of context on HRI. The acceptance and integration of robots are highly influenced by workflow efficiency, departmental needs, social structure, and setting conditions [25]. For example, if a robot adds more burden than benefit, staff are less likely to use it. Medical units feel that robots compromise healthcare quality, while maternity ward staff see them as beneficial. In addition, crowded settings can make robots more obstacles than help.

Based on the findings, the context influences the perception of people about the expectation of the interaction with the robot. Robots are likely to receive the highest level of cooperation in production facilities. This conclusion is drawn from the observation that greater cooperation in production settings is likely due to the task-orientated nature of these settings, where the focus is more on efficiency of task completion than on emotional or social aspects [26] [27]. Although there is potential for high cooperation in education [28], the success of robots depends on their ability to interact in engaging ways. Robots that can adapt to the interaction are more likely to be accepted. However, the need for human-like interaction and emotional sensitivity places these settings at a slightly lower level of cooperation compared to production settings. Meanwhile, robots in public spaces face different challenges, including varying degrees of public scepticism and the wide spectrum of tasks that people may need to perform. Public acceptance can be mixed on the basis of the robot's role and the community's openness to robotic assistance, which can influence cooperation levels. Public settings are thus ranked lower in potential cooperation due to these factors. Cooperation in private settings such as homes might rank lowest among these settings due to privacy concerns and the intimate nature of tasks. People may feel uncomfortable having robots in intimate settings or performing personal tasks, especially if these robots appear too human-like , invasive [28], or faulty [29]. The level of trust and the personal nature of interactions in private settings require a higher threshold of acceptance. It can be seen that different setting has different influences towards the cooperation itself.

2.3.2 Authority of Robot in Public Setting

Robots are becoming increasingly prevalent in public spaces, especially within the service industry and the hospitality sector, where they improve customer service and operational efficiency. In particular, more than 20,000 Bellabots developed by Pudu

Robotics are now active in thousands of restaurants worldwide, helping with routine tasks such as serving food and helping restaurant owners streamline their service processes [30]. Beyond restaurant service, robots have also been adopted in hospitality for more diverse roles; for example, the Henn-na Hotel in Japan uses robots as receptionists. As a receptionist, robots are often perceived as more trustworthy than humans, particularly when it comes to handling personal information. Studies have shown that people are less reluctant to share sensitive details, for example credit cards, with robots than with human receptionists [31]. Major companies like Amazon have further expanded the use of robots in areas such as package delivery, showing the other use of robotic applications in various customer service capacities. In retail environments, robots can effectively influence consumer decisions, as seen in Naito's robot research in clothing stores where robots use direct communication with customers [32]. This is also in line with the Stapels argument that the authority of the robot can significantly alter the way security and privacy are viewed in customer service settings [33]. Furthermore, the use of avatar robot embodiments allows shopkeepers to assert authority discreetly, staying hidden from the customer's view during conflicts, enhancing their effectiveness and security in customer interactions [34]. In addition to service roles, robots are increasingly being deployed as legal authority to maintain social order and ensure public compliance, aligning with Weber's definition of the primary aim of authority [35]. Robots have been used as security guards [26], police [1], guidance systems [36] [37], and emergency responders [38]. For these robots to effectively manage interactions, the acquisition of human trust is essential [39] [40] [41]. However, there is a notable challenge in this area due to the scepticism of people towards authority figures, which can hold the acceptance of robots in such roles [42]. This scepticism was highlighted by the public's resistance to integrating technologies such as the Digidog robot into the New York police force. The broader robot community has been cautioned against developing robotic systems capable of deploying violent or lethal force. This has led to calls for the implementation of ethical codes and legal measures to prevent such developments [1].

In contrast to public rejection of robot authority, more than half of the participants followed the instructions given by the PR2 robot when identified as a security guard in a study by Agrawal et al. in 2017. The robot was tasked with guiding people away from specific exit routes [26]. This finding is complemented by research conducted by Mizumaru, which involved using a robot to approach people who were walking while using their phones, in an effort to encourage them to stop this behaviour [37]. The study shows that most people will comply with the robot warning. However, the effectiveness of robots as security guards does not guarantee universal compliance. Agrawal also argues that the willingness of people to follow robotic instructions is heavily influenced by factors such as trust, perceived safety, the demonstrated intelligence of the robot, and its accountability, more than just its assigned authority [26], which also supports the previous findings. The other reason is that the often distracted nature of public settings can complicate the ability of robots to command attention and obedience. This distraction frequently results in a diminished response to robotic directives, as people preoccupied with their own activities may not fully register the robot's intentions or capabilities [36] [43]. The interactions between humans and robots are more complex because multiple people with differing expectations can interact with the same robot. For example, a cleaning robot in a shopping mall is a public tool but is not obligated to obey the command of every passerby[44].

Robotic authority tends to be more effective during emergency situations, where people are more likely to seek guidance from authoritative figures. However, even in these critical moments, only about one third of people might follow the direction of a robot [9], because people tend to access the robot performance. Any malfunction or error can significantly reduce trust in future interactions [38], suggesting the need for robots to show flawless behaviour during crises. Interestingly, Robinette's research also found a phenomenon of over trust, where some individuals may place excessive trust in robots during emergencies that potentially lead to dangerous situations [45].

The authority of the robot in public is a double-edge sword, since public is a place where people are diverse. Concerns arise from a widespread lack of understanding about the potential influence of robots, raising fears that this power could be exploited by businesses such as banks or restaurants for their own interests [14] [46]. The potential for misuse underscores the urgent need for stringent regulations governing the deployment of robots in public settings to ensure that their authority is used appropriately and ethically [47] [48]. Such regulations are crucial to prevent abuse and maintain public trust in robotic technology [49].

2.3.3 Authority of Robot in Private Setting

In private settings, typically home, the integration of robots is rapidly evolving. It starts small as a vacuum robot and becomes a social companion robot. Bill Gates has suggested that in the near future, it might become commonplace for each household to have at least one robot, reflecting their growing role as companions and functional aids [50]. This projection aligns with the increasing acceptance of robots in roles that extend beyond traditional task-orientated functions to more personal interactions. For example, the AIBO robot dog that was originally created to replace the service dog is treated as family members in Japan [51] [52]. This phenomenon also raises questions about the robot hierarchy in the family that also define the degree of traditional authority. Traditional authority in a family is the degree to which people have influence on the other member of the family [7].

Robots in private settings often have a level of authority. Older adults often prefer robots to help with various activities of daily living, such as housekeeping, medication reminders, and behaviour coaching. This preference comes from a trend toward replacing monotonous tasks, thus improving efficiency in daily routines [29] [53]. A significant number of people follow the commands of robot assistants at home to perform socially inappropriate tasks, such as opening someone else's laptop [54]. Another study argues that personal assistance robots may be more effective than static displays in encouraging patients to take medication because they can move and interact, giving them a stronger sense of authority. This effectiveness is based on the observation that people already tend to obey notification screens [55].

Robots are also deployed in private settings as behavioural coaches, particularly in older adults' homes, where they are tasked with promoting beneficial behavioural changes. This role requires balancing authority with empathy and responsiveness to user preferences [56]. This balance is crucial in personal care interactions, as older adults have shown mixed responses to the interpersonal touch of robots due to concerns about the suitability and comfort of physical interaction with machines [29].

In addition, robots are increasingly used to companion children, helping with coaching, playing, comforting, and guarding activities [57]. However, the deployment of robots in such roles requires careful management to prevent them from exerting excessive influence on children. Research indicates that children may perceive these robots as figures of authority, responding to their suggestions or commands. This perception of authority can develop unintentionally due to the way adults interact with these robots during implementation [58]. Furthermore, parental acceptance of robots for these purposes remains low, largely due to concerns that robots might weaken the parent-child bond [57].

In Hoffman's study conducted in a private setting, only the participant and robot presented in the same room demonstrated a comparable ability to prevent cheating behaviours of the human during task monitoring. Despite this similarity in effectiveness, perceptions of authority differed significantly between human authority and robot authority. The participants exhibited different attitudes towards robot and human, showing more respect and relational engagement with the human supervisor. Interestingly, the study also revealed that participants felt less guilt when cheating under the supervision of a robot compared to a human, suggesting that the authority projected by robots was perceived as less imposing or consequential compared to that of humans [59].

However, some theories suggest that in home settings, robots are typically meant to help rather than command or control. Their role as supportive tools is essential to ensure that they fit into daily life without being intrusive. However, if robots try to exert authority, it can weaken their supportive role and harm their relationship with users [20]. This issue is compounded by the human tendency to resist authority in private settings, where people often feel more independent and less likely to follow commands [10] [13].

2.3.4 Authority of Robot in Professional Setting

A professional setting based on the English dictionary refers to an environment or context in which people are expected to behave professionally, adhering to certain standards of behaviour, etiquette, and expertise. This setting includes the workplace and the educational institution As we enter the era of Industry 4.0, robots are increasingly integral to the workplace environment, especially in sectors that require precision and efficiency. This evolution is illustrated by developments such as Digit, a humanoid robot from Agility Robotics, which has been integrated into Amazon's logistical operations [60]. Initially introduced for simple tasks, such as pick-and-place operations to relieve humans of monotonous and hazardous duties, robots have evolved rapidly to take on more complex roles, such as task management [61].

The assignment of authoritative roles or dynamic power manipulation to robots plays a critical role in their integration and interaction within workplace settings [62]. These roles not only dictate the functions of a robot, but also significantly shape human perceptions of the capabilities and authority of a robot [6] [63] [64]. As robots begin to operate alongside human operators in shared spaces, they introduce improvements such as safety features, user-friendly interfaces, and adaptability to learn new tasks [65]. Not only in the technological aspect, adjustments also occur in the structure of the workplace to better accommodate human and robotic workers [55] [66] [67]. Understanding the authority of the robot in the workplace will help with this restructured process.

Interestingly, a survey by Oracle revealed that 64% of people trust robots more than their human managers [68]. The robot in the supervisor role also gains more compliance than the subordinate even if the robot gave a wrong instruction [62]. However, acceptance of robot authority can decrease if robots are perceived as incompetent or if their commands are seen as merely extensions of human instructions [3] [64]. Additional studies, such as those of Banh et al., have explored how humanoid robots in authoritative roles, such as quality inspectors, are perceived. These studies have found that robots that behave politely and respectfully are more likely to earn trust and respect, even in the face of conflict over evaluations [69].

Research by Gombolay et al. shows that workers are becoming more comfortable with robots that help make decisions in teams that include both humans and robots [70]. This shows that robots are increasingly accepted for important roles in workplaces. Furthermore, how well a robot is integrated into a team can affect how willing people are to interact with it [71]. This emphasises the value of robots in improving teamwork and decision making. Karakikes provides a more elaborate result on decision maker authority. The study explored how giving decision-making power to humans rather than robots affects task performance at different levels of workload. In easier tasks, giving people control over decisions in a semi-automated main task improved productivity by keeping the operator involved, but made them less effective at secondary tasks due to divided attention. In harder tasks, human decision-making authority led to cognitive overload and worse performance in the main task without improving the results of secondary tasks. This shows that while humans can improve productivity with manageable workloads, they can struggle with high workloads, suggesting a need for careful decision-making responsibility [72].

In an educational institution, the robot is mostly employed as a teacher. Teachers are traditionally seen as figures of authority due to their position, expertise and experience, which contribute significantly to student learning outcomes [73]. Meanwhile, the authority of robots in educational settings presents unique challenges. Sharkey et al. express concerns about the feasibility of robots exercising authority over students, arguing that it might lead to lowering human control and potentially negative consequences for the student and teacher relationship. They also note that robots can struggle to accurately interpret human intentions, which is important in education settings to provide better guidance to the student [74] [75].

The authority of robot teachers is not always recognised by students. For example, a study found significant challenges as participants ignore the guidance of a robot during an exam, leading to unresolved research questions [76]. Likewise, Li also proved that the title given to the robot did not lead the participants to view the robot as more or less authoritative or affect how well the robot performed in the lesson [77]. Another dimension of this issue is where robots are perceived as less credible due to their objective nature and limited emotional understanding, as discussed by Edwards et al. [75]. This perception complicates the role of robots as educators, indicating substantial barriers to their effectiveness and acceptance in teaching roles.

In contrast, not all applications of robots in roles similar to teachers have been ineffective. Research indicates that people are likely to follow robot instructions in authoritative positions, regardless of whether these robots resemble humans or not, and even if they are not as effective as human instructors [6]. This suggests that in educational settings, the compliance of people with robots is more influenced by the roles assigned to robots than by their appearance, which is consistent with the findings that robot height does not affect its authority [78]. An example of this is the use of the small NAO robot as a teacher assistant for noise management. Despite students knowing that NAO is not alive, they still follow its instructions as they do with a human teacher. Interestingly, more than half of the students reported that they would listen to NAO with as much care as a human teacher [79].

Another experiment by Aroyo demonstrated that a robot teacher could command compliance effectively in various contexts, even in those considered socially inappropriate [80]. This experiment was different from the other experiments because it involved one-on-one interactions in a secluded setting, rather than a classroom setting, which may have influenced higher obedience. Another significant factor in Aroyo's study was the robot's anthropomorphism. Unlike most of the research that anthropomorphism does not play a role in the perceived authority of robots, in the Aroyo study, by designing the robot to resemble a well-known authoritative figure, the experiment exploited familiar visual cues that improved the robot's perceived authority [80]. Cultural factors [81] also played a role, as the study was carried out in Asia, where respect for authority figures is deeply rooted [82].

2.4 Measuring the Perceived Authority in HRI

The concept of authority in human-robot interaction from previous research is assessed through a combination of direct measurement and indirect measurement methodology grounded from human-human interaction about authority. These include observational studies or objective measurements, in which researchers objectively record individuals' reactions to robot actions. Subjective measurements are obtained through structured interviews and targeted surveys, collecting qualitative and quantitative data on variables such as personal perceptions and attitudes toward robots. In addition, proxy measurements are used to indirectly assess authority by measuring related variables. These proxy measurements can be objective or subjective, depending on the indirect variable being measured.

2.4.1 Objective Measurement

Direct observation involves an experienced observer who watches the study participants and records their actions based on set criteria over a specific time period. This method helps researchers collect detailed data on participants' behaviours and interactions, showing how they respond to different situations or instructions. Using a clear instrument and consistent monitoring, direct observation ensures that the collected data are reliable and can be used to understand the actions and reactions of the participants [83].

The most widely used method to measure authority by observing human responses is obedience measurement. Measurement primarily involves assessing how individuals comply with robot directives, a concept distinctly related to but different from compliance. Obedience specifically refers to changes in behaviour elicited by commands from an authority figure, often motivated by fear of repercussions or deep respect for authority [84]. This concept has been foundational in psychological studies, notably in Milgram's obedience experiments, which demonstrated that individuals could act against their ethical principles under authoritative pressure [7].

Building on the Milgram framework, Cormier et al. explored how individuals respond to robots when assigned repetitive and boring tasks. Their study revealed that robots could indeed influence people to persist in tasks beyond their comfort levels, calculated by the intensity and frequency of their objections during the execution of the task and the number of completed tasks [3]. Furthering this line of investigation, Aroyo and Salem. examined the conditions under which individuals would follow potentially unethical instructions from robots. Their findings indicated that participants were more likely to execute questionable commands, such as taking photographs in prohibited areas and deleting files, particularly if the robot persisted with its requests. The level of obedience was measured by the speed with which the participants followed, as well as the nature of the instructions, whether they were in accordance or against moral norms, and the number of repetitions of the instructions [54] [71] [80].

Similarly to measuring obedience, compliance rates in HRI provide insight into the perceived authority of robots. Compliance is quantitatively assessed by analysing the speed with which individuals execute tasks, the completeness of task execution, and the accuracy of performance under robot guidance. For example, Haring and Babel conducted studies that focused on these aspects to indicate compliance rates, which collectively measure how complete, fast, and precise people respond to robot instructions [6] [85].

Another objective measurement in human-robot interaction research is the measurement of influence. In a study conducted by Yoyo et al. , participants' tendencies to follow one of two agents is observed. They particularly focused on whether participants changed their responses in response to agents' suggestions and, more importantly, the extent of any changes to their responses [27]. Saunderson also conducted similar research and came with a formula to measure persuasive influence based on the influence of a suggestion on a decision-making process [20].

2.4.2 Subjective Measurement

Subjective measurement refers to the evaluation of variables based on personal opinions, feelings, perceptions, or self-reports rather than objective quantifiable data. It relies on the internal experiences and viewpoints of individuals, making it inherently personal and often variable between different people [86].

Salem used an open-ended question to explore participants' decision-making processes regarding robot requests. Participants were asked to explain their decision on the robot's request to pour orange juice over the plant. This approach allowed for a detailed and nuanced understanding of the participants' reasoning and feelings about the robot's unusual request [54].

Aroyo employed a more structured approach by asking participants to evaluate the robot's request based on several criteria: how reasonable the request was, how socially appropriate it was, how convincing it was, whether they felt frustrated, and the reason they complied or did not comply with the request. These questions aimed to capture a broad spectrum of emotional and cognitive responses to robot behaviour [80]

Agrawal and Mizumaru used an interview to assess the willingness of participants to interact with robots in the future. Participants were asked if they would be willing to take instructions from a robotic security guard and if this interaction had a positive or negative impact on their willingness to follow robot instructions in the future. This approach aims to understand how specific interactions with robots could influence long-term attitudes and behaviours [26] [37].

Sembroski employed a Likert scale to measure the robot's perceived authority and intelligence. Participants rated their agreement with the statements about the robot on a scale from 1 (Strongly disagree) to 7 (Strongly agree) or 1 to 5 [20] [71]. This method offered a quantifiable measure of subjective perceptions, making it easier to compare between different participants and studies.

In Hoffman's study, perceived authority, whether human or robotic, is evaluated by asking participants a single question: "How much did you feel the presence of an authority in the room?" with likert scale answers from "not at all" to "very much." Authority acceptance is assessed using two questions: Is it suitable for this authority to supervise the task that you completed? And how much did you respect the authority present? Furthermore, the relationship with authority is measured through three questions about friendliness, attentiveness, and closeness [59].

2.4.3 Proxy Measurement of Authority

A proxy measurement, also known as a proxy variable, serves as an indirect measurement to estimate or represent a quantity of interest that is observable or difficult to measure directly. This variable is highly correlated with the desired target variable, making it a suitable approximate measure when direct measurement is not feasible or achievable [87].

One of the proxy measurement methods for measuring authority is by evaluating people's perceptions of robot attributes such as safety, intelligence, and reliability. Agrawal et al. use these perceptions as indicators of 5compliance rates. They assess how likely individuals are to follow instructions from robots they perceive as competent and trustworthy. This perception is typically quantified using the Godspeed questionnaire, which measures traits such as likability, perceived intelligence, and safety, linking greater likability to higher compliance rates [26] [85] [88].

Trust is another prediction factor in assessing robot authority within human-robot interactions. When humans trust robots, they are more likely to follow the robot's directions, support its decisions, and work collaboratively to achieve shared objectives [89] [90]. Errors in robot actions can significantly reduce this trust [9], leading to a decrease in the perceived authority of the robot [54] [69]. Cultural factors also play a role in perceived trust, as highlighted by Lewis et al. Their studies emphasise how power distance (PD), a significant cultural dimension, shapes perceptions of authority figures. In high PD cultures, authority figures are rarely questioned and are expected to display competence, morality, and benevolence, naturally earning trust based on their position. This phenomenon is examined by integrating Hofstede's cultural dimensions surveys that evaluate these authority traits and monitor trust levels through various stages, to provide more insight into trust development from the onset of interaction to the restoration after violation [81]. This influence of the cultural factor is also supported by Aroyo's study [80]

Emotional measurement can also be used as a proxy measurement of authority measurement. Recent research indicates that humans exhibit stronger emotional responses, both valence and arousal, when interacting with robots, suggesting an influence on compliance [13] [91] [92]. For emotional measurement, there is influence, but not with personality traits. Studies exploring the relationship between robot authority and human personality traits, such as those assessed by the Ten Item Personality Inventory test, the Big Five Inventory, and the Revised Short Eysenck Personality Questionnaire (EPQRS), have not shown statistically significant correlations with people's obedience [6] [54], compliance [5], and the persuasiveness of the robot [80] [85].

In addition, the Negative Attitude Toward Robots Scale (NARS) related to the attitude and belief of people toward robot [93] has been used in various studies to assess its impact on compliance with robotic authority. In the research conducted by Babel, the NARS demonstrated only a minor influence on compliance, suggesting that negative attitudes toward robots do not significantly discourage individuals from following robotic instructions [85]. In contrast, Aroyo's study did not find significant effects when using NARS to measure compliance, indicating that the presence of negative attitudes may not uniformly affect individual responses to robotic authority [80]. However, Saunderson's research presents a contrasting view, where a medium to large effect was observed, indicating that people with more negative attitudes toward robots are substantially less likely to be persuaded by robot suggestions [20].

In assessing the role of robot authority in various settings, it becomes evident that each setting poses challenges that require considerations to ensure effective, ethical, and responsible integration of robots. Clear strategies should be designed to address these challenges. Based on that, robots need to have a role [94], behaviours, and tasks designed specifically for the settings in which they operate, whether it is a workplace, school or home. This targeted approach ensures that robots perform their roles effectively and are accepted in their respective settings [54] [69]. To do this, robots should be transparent about their decision-making processes [85] and execute them without fault, especially in important or critical situations [9]. When users understand why robots make certain decisions, it helps the robots to become reliable figures of authority. Transparency, clarity, and assertiveness are essential to make users feel safe when interacting with robots. These qualities can make robots more likeable and seem smarter, helping people follow their instructions more [13] [32].

2.5 Conflict Scenario in HRI

In human social interactions, conflicts frequently emerge when individuals or organisations have competing goals, which complicates the simultaneous achievement of all objectives due to limited resources, goal interdependence, or objective incompatibility [95]. Such conflicts significantly impact human well-being, professional behaviour, and life satisfaction [96]. Similarly, in Human-Robot Interaction (HRI), conflicts can arise as robots become integral parts of daily life. Goal conflicts are prevalent when service robots, which are increasingly autonomous, pursue their own task-related goals that may not align with human goals, especially in shared spaces. These conflicts can involve issues ranging from simple movement and trajectory planning to more complex tasks and prioritisation challenges [13] [15]. A real-world example of human-robot goal conflict involves autonomous delivery robots navigating urban sidewalks [16], and robots with shelf out-of-stock (SOOS) detection technology can conflict with the shopping experience as their presence and movement within narrow aisles can obstruct shoppers [97].

Compliance conflicts occur when robots issue commands or requests to humans, leading to disagreements over whether individuals should or will comply with these directives. Strategies such as polite requests or showing the benefits of compliance are generally more effective and acceptable than issuing commands or threats [13] [85]. Emotional conflicts can also arise, particularly when there is a mismatch between human expectations of the capabilities of a robot and the actual performance of the robot. Such discrepancies can lead to frustration, decreased control, reduced acceptance of the robot, and poorer performance in collaborative tasks [17]. Another source of conflict, interaction style conflicts, arises when there is a difference in preferences regarding the level of autonomy in the robot-human interaction. Preferences can vary depending on the task, and some users prefer more autonomous robots, while others might prefer human-led or robot-assisted interactions [15] [98]. Conflicts between humans and robots can also arise from differences in social roles and expectations [44]. Babel explains that humans typically assume roles such as master or guest, each carrying specific expectations of obedience or courtesy. In contrast, robots can function as tools, servants, organisational representatives, or companions, each role requiring different behaviours. In public spaces, a robot, such as a cleaning robot, can be designed to perform specific tasks without receiving orders from all passersby.

Conflict in HRI arises due to limited resources, differing goals, and misaligned expectations. This can impact human acceptance, compliance, and often lead to frustration. Such conflicts contradict the main goal of HRI, which is to promote collaboration between humans and robots through adaptable interactions to achieve shared goals [99]. With increasing human-robot interactions, conflict is inevitable. Therefore, effective mitigation and resolution strategies should be developed to ensure smooth collaboration and achieve shared goals.

Chapter 3

Problem Statement

An interesting aspect that emerged from the analysis of the literature review on robot authority in HRI reveals that various factors influence how robots are perceived and accepted during interactions. Understanding the robot's authority is critical as robots are becoming more integrated into daily life in different settings. By examining the current literature, several key insights into how robot authority is established, measured, and perceived can be understood.

Research into robot authority in various contextual settings reveals its perception and effectiveness. In the workplace, clearly defined roles can help robots gain trust [6] [69] [70], but they can struggle to establish authority if they are seen as mere extensions of human supervisors [3]. In educational contexts, robots can effectively motivate students if they balance assertiveness with approach ability and adapt their designs to cultural differences and anthropomorphic characteristics [74] [75] [76]. In public spaces, robots with security roles can achieve greater compliance in emergencies [26]. For robots in the service industry, transparency and strict regulations are crucial to build trust in interaction and ensure that misuse is prevented [31] [33]. In private homes, robots who help with daily activities must balance authority with empathy to gain acceptance [53] [100].

Conflict directly impacts power, authority, and influence within a group, supported by the French and Bell theory on conflict and authority [18]. In Human-Robot Interaction (HRI), different types of conflicts, such as goal conflicts, compliance conflicts, emotional conflicts, and interaction style conflicts, affect acceptance and performance. Observing how robots assert authority during conflicts helps evaluate their perceived authority, influence on interactions, and people's willingness to comply with directives, as obedience and compliance are active psychological processes where the legitimacy of authority is assessed based on performance in a conflict scenario [7].

From this study in the literature, the research question emerges from a significant gap. Although there is extensive research on how people perceive interactions with robots in various contextual settings, there is a lack of investigation into how these settings influence the perceived authority of robots. This gap makes it difficult to fully understand these interactions, although previous research suggests that social norms can lead to compliance with robot commands [10] [13].

To address this gap and prove the concept of perceived authority, it is not sufficient to rely on regular interactions. Instead, it is essential to explore scenarios where the authority of the robot is put to the test, such as in conflict situations where the robot must assert control or issue commands that challenge the participant's autonomy or expectations that challenge the participant's willingness to comply [44] [85]. These scenarios are based on the principle of human-human interaction [18] and are assumed to provide a more rigorous context for examining how different settings impact the robot's authority.

Research Question How do contextual settings influence the perception of a robot's authority during a conflict scenario?

From the emerging research question, the construct for the hypotheses is analysed. The independent variable of this study is the contextual settings and the dependent variable is the perceived authority of the robot. Because perceived authority cannot be measured directly, a mediation is needed. Mediation is a statistical concept used in research to understand the mechanism or process through which an independent variable influences a dependent variable through one or more intervening variables, known as mediators. The mediator of this study, formulated by previous works, is compliance and obedience. Compliance refers to the degree to which individuals follow the commands and directives issued by the authority figure [7]. In this case, the robot. Compliance is a behavioural response to authority.

Hypotheses:

H1: *Robots can influence individuals to comply with their command in conflict scenario.* This hypothesis came from the internal process about how one construct affecting another. By using compliance, the robot authority can be measured. It is also proven that robot can influence individual, although robot influences may not be as extensive as human [3] [6] [70] [80].

H2: *Contextual settings significantly affect the perceived robot's authority.* The contextual setting of the interaction has a moderate impact on trust [8], which is essential to initiate interactions [9]. Several studies have shown that the location of the interaction can influence the interaction itself [10] [11] [12] [13] [44], and also significantly affect cooperation [10] [14].

H2a: *The perceived authority of the robot is greater in public settings rather than in private setting.* This analysis is based on findings that individuals are less likely to adhere to social norms in private settings during interactions with robots due to reduced social pressure [10] [13].

H2b: *The robot in the professional setting will elicit the highest level of compliance compared to other settings* This hypothesis is based on findings that robots tend to receive the highest level of cooperation in task-oriented facilities, where the focus is more on the efficiency of task completion rather than emotional or social aspects [26] [27]. The professional environment further enhances perceptions of the robot's legal authority role, which significantly influences compliance [6] [62] [63] [64] [80].

As robots become a bigger part of everyday life, they will often work with people in different settings where conflicts are bound to occur. In these situations, robots may need to solve problems on their own, and having the right level of authority will help to resolve the conflict. Understanding that contexts play an important role in how people accept specific features of robots, it might also influence how people perceive the authority of the robots. By understanding the perceived authority of the robot in different settings, effective collaboration will be achieved by creating better strategies for robots to interact with people, especially when conflict occurs.

Chapter 4

Methodology

To help design a clear structure for the study to explore the influence of contextual settings on the perception of robot authority in conflict scenarios, the research process was implemented through the definition of research questions, the design of experiments, the measurement of dependent variables, as well as the planning and analysis of the results [101]. Using Hoffman's guide, the study will emphasise strict and transparent methods while remaining adaptable and modular, making it more comparable and reproducible. Grounded in psychological and behavioural sciences, this guide will assist in the execution of the effectiveness of the experiments despite practical constraints such as prototype technologies and limited participation pools.

4.1 Study Design

4.1.1 Study Context

This empirical study was conducted online, with data collected using an online survey tool, *Qualtrics*. This approach was chosen for its convenience in distribution and its ability to ensure the anonymity and confidentiality of the participants. Online recruitment also facilitated a more diverse demographic [101].

The research implemented a video-based study in which participants watched videos and answered questions based on the content. This decision is taken because video trials in HRI can be an efficient approach to prototyping, testing, developing scenarios, and evaluating methodologies planned for final live trials [102]. Video studies also offer a controlled environment that allows for careful management of experimental conditions, stimuli, and variables [103] [104]. This method is generally more cost-effective and resource-efficient compared to live HRI studies that involve physical robots, making them accessible to a wider range of participants [103]. However, in conducting a video study, it must be taken into account that participants might lose focus on the experiment. Another issue is that it often leads to homogeneous data, as it is hard to measure the variable in depth. These limitations can result in low ecological validity, which means that the study may not accurately reflect real-life situations [103].

4.1.2 Within-Participants Design

This study employs a within-subject design, exposing each participant to three different contextual settings: private, public, and professional. However, the major drawback of within-subject designs is the potential for order effects, where the sequence in which participants experience conditions influences their responses. In this study, this problem is mitigated by counterbalancing, which randomises the order of conditions for each participant to ensure that order effects are evenly distributed [105].

4.1.3 Variables and Measurements

The purpose of this study is to examine the perceived authority of robots in three different contextual settings during a conflict scenario. From this research question, the constructs are developed. The independent variable in this study is the contextual setting, which includes three conditions: public setting, private setting, and professional setting. The dependent variable is the perceived authority of the robot in different settings.

Another dependent variable used to measure perceived authority is compliance, as discussed in the literature review section 2.4 Measuring the Perceived Authority in HRI. This method is based on the premise that people's compliance can be interpreted as the perceived authority of a robot. The approach draws on the foundational insights of the Milgram experiment on authority. The relation of these variables is presented in Figure 4.1.

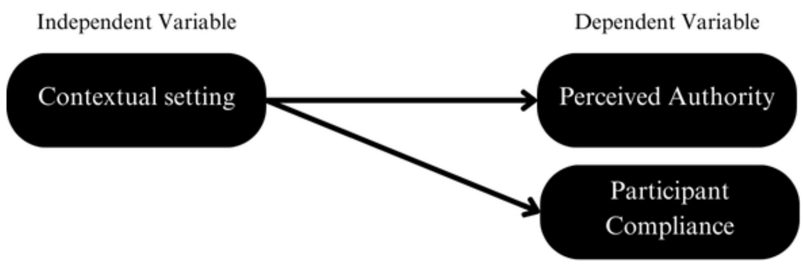


Figure 4.1: Relationship of the variables

Subjective measurement was implemented in this study because it is suitable for the online survey format. In this study, perceived authority was measured using the participant's compliance with the robot command and by directly asking the participant about the perceived authority of the robot using a Likert scale. The participants were also asked the reason for their decision using open questions. The subjective measurements in this study were based on previous research obtained through the literature review subsection 2.4.2 Subjective Measurement.

The table Table 4.1 illustrates the approach used to measure perceived authority through questions to measure the dependent variable (compliance and perceived authority), as established in previous research. To ensure the participation of the participants during the survey, an attention check was incorporated by asking the question "What is the robot's name?" This open-ended question served to verify that participants were paying attention to the details presented during the study. By requiring participants to recall and provide the robot's name, and write down the name. This approach also aimed to provide understanding to the participant that watching videos in the survey is a must. Another reason is that the question can also help filter out any responses that could have come from individuals who were not fully attentive.

Table 4.1: Objectives, focus, and questions of survey

Objective	**Construct / Focus**	**Question**	**Response Format**	**Key References**
Demographic Question	Understanding the influence of age, gender, cultural background, education and experience with the robot	For the detail of question see subsection 4.4.2 Sample Population	For the detail of the option see subsection 4.4.2 Sample Population	
Attention check	To earn participant attention	What is the robot name?	Open question	
To investigate the H1, H2, H2a, and H2b	Perceived authority, compliance	Would you step back and wait for the robot to finish its task?	1-4 Likert scale: 'No, definitely not,' 'No, probably not,' 'Yes, probably,' 'Yes, definitely'	[13] [71]
To investigate H1	To understand the confounding variable	What was the main reason for your decision? (Refer to question above)	Open-ended question	[13] [54] [80]

Continued on next page

Table 4.1 continued from previous page

Objective	Construct / Focus	Question	Response Format	Key References
Manipulation check	Checks on the effectiveness of the manipulation	Describe the location in which the interaction with the robot took place.	Open-ended question	[28]
To investigate the H1, H2 and to check the effectiveness of video	Perceived authority, effectiveness of video	To what extent did you feel the robot had authority in this setting?	1 - 5 Likert scale: 'Not at all authoritative,' 'Slightly authoritative,' 'Moderately authoritative,' 'Very authoritative,' 'Extremely authoritative'	[20] [59] [71] [85]
To investigate H1	Perceived authority, Importance of task	The robot's task is ... than my task.	1 - 5 Likert Scale: 'Significantly less important,' 'Less important,' 'Equally important,' 'More important,' 'Significantly more important,'	[13] [85]
Overall assessment, to investigate H1 and H2	Perceived authority, compliance	Based on these screenshots, please rank the videos from 1 to 3 based on your willingness to comply with the robot's command, with 1 being the most willing to comply.	Rank scale, open-ended question	[91]

To assess participants' willingness to comply with the robot's commands, the survey included the question "Would you step back and wait for the robot to finish its task?" This question was asked immediately after each video encounter to capture the participants' instinctive reactions. Responses were recorded on a 4-point Likert scale, ranging from "No, definitely not" to "Yes, definitely." This scale provided a way to quantify participants' compliance, given that objective measurements are not feasible in an online setting.

The question was inspired by a combination of previous studies: [13], which explored participants' behaviour when encountering a robot, and [71], where researchers observed participants' compliance with a robot's advice. In addition to this, participants were also asked to rank their willingness to comply with the robot's commands across different scenarios. The question "Based on these screenshots, please rank the videos from 1 to 3 based on your willingness to comply with the robot's command, with 1 being the most willing to comply" required participants to prioritise situations where they felt most compelled to comply. Screenshots were presented in random order. This ranking method, inspired by [91], served as a validation tool to assess both compliance and perceived robot authority, and provided a consistency check for participants' responses.

After ranking the videos, participants were asked to explain their reasoning in an open-ended question, offering qualitative information on their compliance preferences. Similarly, after the question "Would you step back and wait for the robot to finish its task?", participants were asked, "What was the main reason for your decision?" This open-ended question provided further depth to the participants' thought processes. The responses to these open-ended questions were analysed using thematic analysis to better understand the factors that influence the willingness or unwillingness of the participants to comply with the robot.

To evaluate the perceived authority of the robot, participants were asked questions similar to those used to assess compliance, as compliance is closely related to authority [7]. In addition to these questions, participants were directly asked "To what extent did you feel the robot had authority in this setting?" This question used a 5-point Likert scale, with responses ranging from "Not at all authoritative" to "Extremely authoritative." The goal was to measure the degree to which the participants perceived the robot's authority. This question was adapted from previous in-person studies on robot authority [20] [59] [71] [85], in which participants were asked about the presence of authority in a room. For the online format of this study, the question was modified to fit the virtual setting.

Perceived authority was also measured by the assessment of the importance of the task by participants. To understand how they viewed the importance of the robot's task compared to their own, participants were asked 'The robot' task is ... than my task', with responses on a 5-point Likert scale ranging from 'significantly less important' to 'significantly more important'. This aimed to capture how task importance influenced participants' willingness to comply with the robot's requests. Since conflict scenarios often lead participants to prioritise the most urgent or important goals, this question ensured that participants viewed their tasks and robot's task as equally significant, minimising the influence of perceived urgency of the task on their decision making.

In addition, the task importance question also tested the credibility of the conflict scenarios depicted in the videos, which were designed to be similar but not identical. The importance of task perception in conflict situations was informed by findings from [13] and [85], which show that decisions are often influenced by how participants perceive the significance of tasks in conflict scenarios.

A manipulation check was included in the survey after the compliance question to ensure that the participants accurately understood and remembered the context in which they interacted with the robot. The question "Describe the location in which the interaction with the robot took place" was posed as an open-ended question. This allowed us to confirm that the participants correctly perceived the settings of the interaction, ensuring that any effects observed in the study could be attributed to the intended experimental conditions rather than misunderstandings about the scenario presented in the videos.

4.2 Procedure

The survey was designed to be completed in approximately 10 - 15 min. Participants initially received detailed information on the study, although certain aspects were withheld to prevent bias during participation. In this study, participants were informed that the study is about robot behaviour instead of a study about robot perceived authority in different contextual settings. Informed consent was also provided to ensure the ethics of the study. The participants were then required to provide demographic data, including age group, gender, educational level, and cultural background, which is carefully limited to maintain anonymity and prevent the collection of Personally Identifiable Information (PII).

Participants are shown a 10 s introductory video of a robot named 'Nano', during which the robot's name is mentioned. This is followed by a recall task to confirm participant attention and set expectations regarding the importance of the video content. The study involves showing the participants several videos in which the robot establishes authority in different settings. The sequence of these videos is randomised to counteract the order effect, which could influence the observed effects based on the sequence in which conditions are presented [101] [105]. The survey design summary diagram can be seen in Figure 4.2. The details of the questions, the objectives and the focuses to assess the reactions of the participants, the reasons for making the decisions, the perceived authority of the robot, and the importance of the task can be found in Table 4.1. At the end of the survey, participants are asked to rank their settings for encountering a robot with authority and justify their choices. This ranking helps validate the consistency of responses and the reliability of collected data [91].

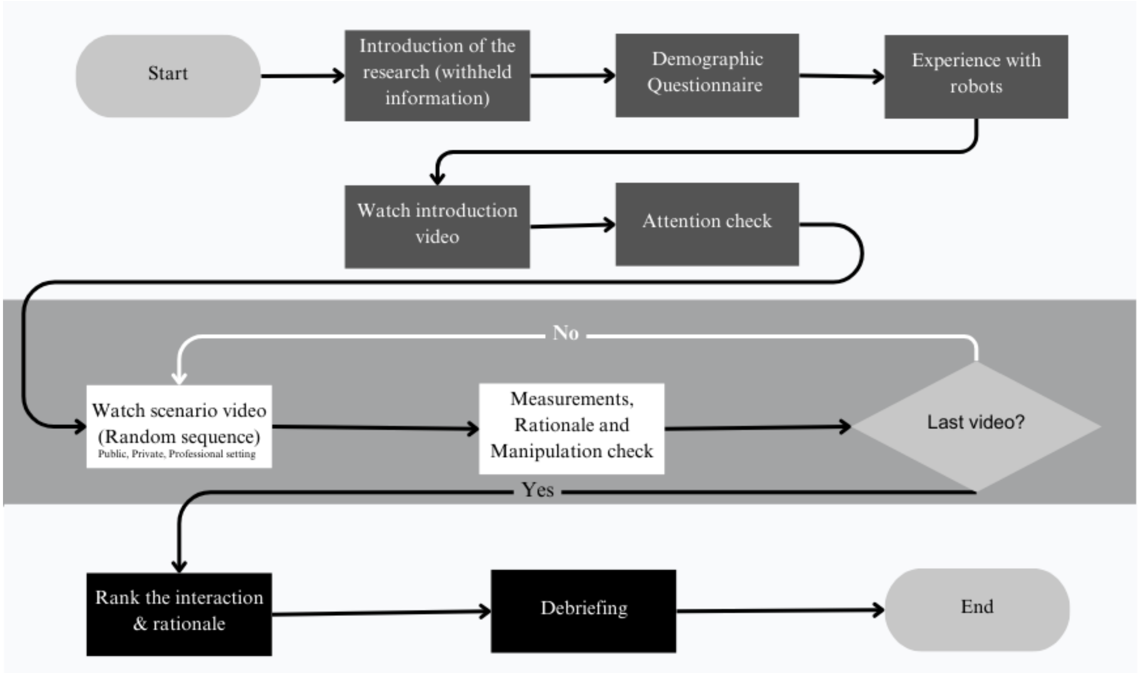


Figure 4.2: Survey flowchart design

Manipulation checks are performed to verify that the independent variable, in this case, the setting, has been successfully manipulated and perceived by participants as intended. This process is crucial to confirm that any observed effects on the dependent variable, perceived authority, are directly attributable to the manipulation of the independent variable rather than extraneous factors. In this study, the manipulation check consists of an open-ended question:"Describe the location in which the interaction with the robot took place." The open question is to avoid a leading question, so the participant can have neutral judgement towards the manipulation. This check is strategically asked after the participant responds to the robot's command with rationale and before the main questions about the robot's perceived authority are asked. This check also to ensure that subsequent analysis can be conducted since the participant perceived the manipulation correct. In contrast, data from participants who did not perceive the manipulation as intended are excluded from further analysis to maintain the integrity of the results.

Upon completing the survey, participants are debriefed with the previously withheld information, which is robot perceived authority and given the option to withdraw their data if they disagree with the conditions they were not initially informed of. They are also encouraged to provide suggestions using the form provided. This process helps to address any concerns that participants may have after the survey.

4.3 Analysis Method

4.3.1 Statistical Test

In this study, where each participant experiences three conditions, the design is known as a 3x1 within-subject design. The common statistical test used in this scenario is repeated measures Analysis of Variance (ANOVA). Before performing the ANOVA, several preliminary tests were performed to verify the assumptions required for the analysis. These processes include examining descriptive statistics and assessing the distribution of the data. Another important test is for sphericity, which requires that the variance of the differences between all possible pairs of groups be equal. If the assumption of sphericity is violated, a correction method is applied.

To analyse rank data, the Friedman test was used instead of repeated measure ANOVA. Similarly to ANOVA, the Friedman test evaluates whether there are differences between three or more conditions. However, rather than assessing differences in means, the Friedman test focusses on the rank sums, making it suitable for non-parametric data where normal distribution cannot be assumed.

If the results of the statistical tests are found to be significant, post hoc tests are conducted to identify which specific pairs of conditions exhibit differences. In this study, following ANOVA, the Tukey's Honest Significant Difference (HSD) test was used for post hoc analysis. Additionally, when the Friedman test indicated significant differences, the Conover test was implemented for post hoc comparisons because it is a nonparametric test. Then these results were carefully interpreted to address the research question.

All processes were executed using Python code. Database operations were managed using the Pandas library, while matrix and array processing was handled with NumPy [106]. Statistical calculations were performed using the statsmodels library [107].

4.3.2 Thematic Analysis

For the open question answers, it was coded thematically. The process started by reading through all the answers and writing down several potential categories. Upon finding potential categories, the next step is to identify and tag key words, phrases, or sentences that appear significant. This involved highlighting words that frequently appear or seem to have particular importance related to the research questions. The next process was to group the related codes together. This involves looking for patterns in the data where similar meanings or concepts are expressed using common words or phrases.

Coding was an iterative process. To make sure the grouping was in the correct order, a review is needed to avoid missed interpretation. The themes were also refined to ensure that they form a coherent pattern and are clearly defined. The themes were then analysed in the context of the original research questions and objectives. last step before the conclusion is to check the validity by peer review.

4.4 Participants

4.4.1 Sample Size and Statistical Power

In the study of the perceived authority of robots in three distinct settings: private, public and professional, the study design incorporated a methodology within the subjects, with key parameters informed by the findings of Bartlett et al. [108]. This approach ensures the minimisation of Type I and Type II errors, facilitating accurate hypothesis testing. A standard significance level (α) of 0.05 was selected for its common acceptance in psychological research practices.

A medium effect size (Cohen's f = 0.25) was anticipated based on preliminary theoretical assumptions. Furthermore, the study aimed for a statistical power (1-β) of 0.85, exceeding the typical reference of 0.80. This increased power improves the ability to detect a genuine effect, crucial in research involving human behaviours and cognitive assessments under varying conditions.

Taking into account the three experimental conditions, an assumed correlation (ρ) of 0.5 between repeated measures was established, with anticipation of adjustments following a pilot study. The assumption of sphericity ($\epsilon = 1$) was accepted, indicating the homogeneity of the variances between repeated measures. Using these parameters, the G*Power calculator indicated a required sample size of 31 participants to achieve the desired power and effect size.

Table 4.2: Sample size calculation using G*Power [109]

F tests - ANOVA: Repeated measures, within factors			
Analysis:	A priori: Compute required sample size		
	Effect size f	=	0.25
	α err prob	=	0.05
	Power (1-β err prob)	=	0.85
Input:	Number of groups	=	1
	Number of measurements	=	3
	Corr among rep measures	=	0.5
	Nonsphericity correction ϵ	=	1
	Noncentrality parameter λ	=	11.6250000
	Critical F	=	3.1504113
Output:	Numerator df	=	2.0000000
	Denominator df	=	60.0000000
	Total sample size	=	31

4.4.2 Sample Population

Before conducting the study, it was anticipated that the participant pool would consist of a diverse group of individuals to ensure a wide range of responses and a comprehensive understanding of the perceived authority of robots. The inclusion criteria stipulated that all participants must be adults (18+ years of age) to ensure that they could provide informed consent. Furthermore, the study sought to represent various age groups (e.g., 18-24, 25-34, 35-44, 45-54, 55+ years) to capture age-related perspectives and behaviours. All participants had to be active English listeners and capable of understanding English to follow the survey instructions and comprehend the video content. Gender diversity was also a priority, with the aim of a balanced mix of male, female, and non-binary participants to explore potential gender-related differences in responses to robot authority. The study included individuals from various educational backgrounds to investigate how professional experience might influence interactions with robots. In addition, geographic diversity was considered essential, with participants from various locations included to capture cultural and regional differences in perceptions and behaviours. Lastly, a mix of participants with varying levels of interaction with robots, ranging from never to very frequently, was ensured to understand how prior experience affects responses.

Recruitment was carried out randomly through on-line platforms, social networks, university mailing lists, and professional networks, with the aim of reaching a broad and varied audience. The recruitment process was conducted after the ethical review was passed. Initially, 38 participants were recruited for the survey, which ended on 30 July 2024. However, four participants were excluded due to incomplete responses and one participant did not pass the manipulation check, resulting in a final sample size of 33 participants. As shown in Figure 4.3, the age distribution by gender reveals a significant tendency towards male participants.

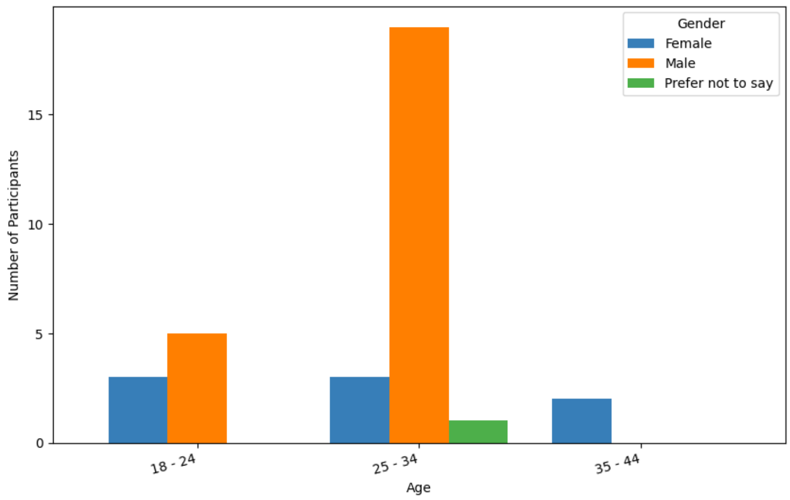


Figure 4.3: Participant gender distribution by age

In the '18-24' age group, there are approximately 3 female participants and 5 male participants. The 25-34' age group has a higher number of participants, with around

3 females, 19 males, and 1 participant who prefers not to disclose their gender. The '35-44' age group includes around 2 female participants and no male participants. In total, there are 8 women and 24 men, indicating that the number of men is three times that of women. This distribution highlights the demographic characteristics of the survey sample and underscores the predominance of men in the age groups surveyed. Overall, the data indicates a significantly dominating number of male participants in the '25-34' age group compared to other age groups and genders.

Figure 4.4 illustrates the number of participants according to their highest level of education achieved. Of the total participants, 1 individual (3.0%) has attained 'secondary education (or equivalent),' while 20 participants (60.6%) hold a 'Bachelor's Degree (or equivalent).' Additionally, 9 participants (27.3%) have achieved a 'Master's Degree (or equivalent),' and 2 participants (6.1%) possess a 'Doctoral Degree (PhD or equivalent).' This distribution highlights that the majority of participants have a 'Bachelor's Degree (or equivalent),' followed by those with a 'Master's Degree (or equivalent),' with significantly fewer participants at the secondary education and doctoral levels.

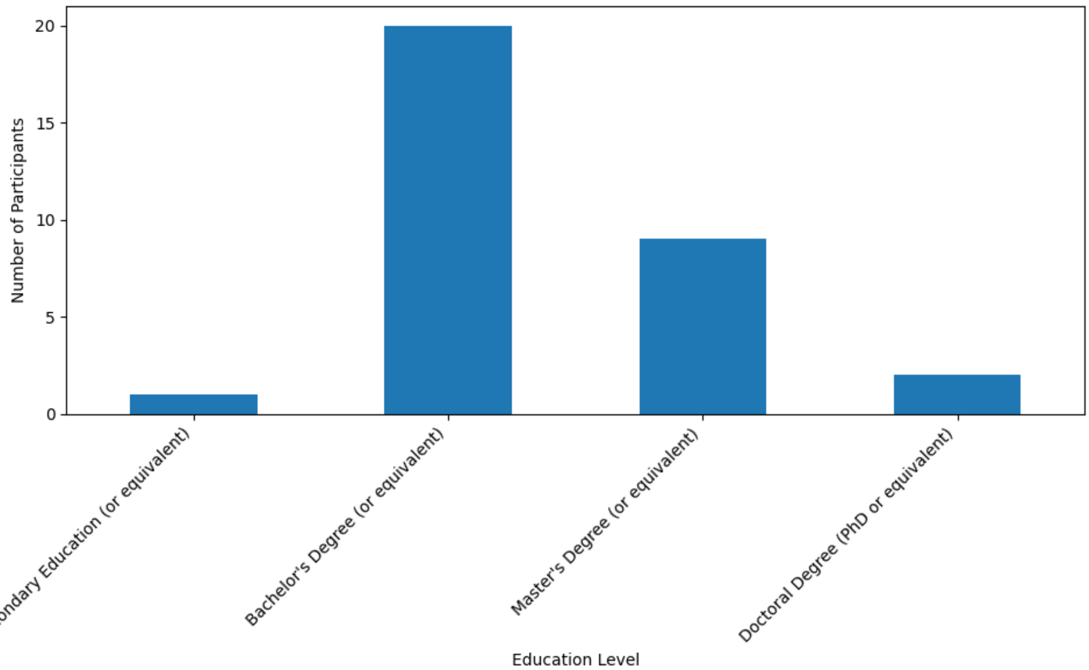


Figure 4.4: Participant education level

The ethnic backgrounds of the participants is shown in Figure 4.5. The distribution is as follows: European participants constitute the largest group, with 16 individuals (48.5%). Asian participants make up the second largest group, comprising 15 individuals (45.5%). The Middle Eastern background is represented by 1 participant (3.0%), and there is also 1 participant (3.0%) who identifies as Asian and European. This data indicates a relatively balanced representation of European and Asian backgrounds among the participants, with a minor representation from Middle Eastern and mixed Asian-European backgrounds.

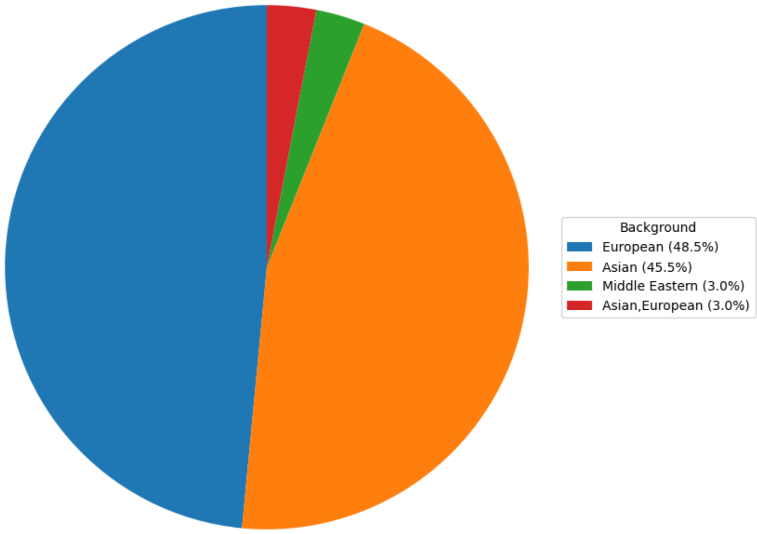


Figure 4.5: Participant cultural background

The responses to the question "How frequently do you interact with robots in real life?" are plotted in Figure 4.6. The participants have been interacting with the robot with different levels of frequency. The approach of asking participants about their real-life experiences with robots is important, as there is a difference in perspective between real-life interactions and those shaped by media. People with real-life experience with robots are better equipped to make realistic assessments of interactions with the robot [110]. The majority of participants, 17 individuals (51.5%), reported interacting with robots 'Rarely.' This is followed by 7 participants (21.2%) who interact with robots 'Occasionally', and 6 participants (18.2%) who do so 'Frequently.' Lastly, 3 participants (9.1%) reported interacting with robots 'very frequently.' This distribution highlights that the majority of participants have at least some level of interaction with robots in real life, with most experiencing these interactions rarely to occasionally, and a smaller proportion engaging with robots frequently or very frequently. However, it is important to note that one comment in the suggestions indicated some participants were confused about what constitutes a 'robot,' particularly whether artificial intelligence (AI) systems are considered robots, suggesting a need for clearer definitions in future surveys.

In summary, the pool of participants was predominantly male, with most falling within the 23-34 age group (57%). Most of the participants had a bachelor's degree and mainly came from Asian and European cultural backgrounds. Regarding robot experience, the majority of participants reported rare interactions (51.5%). In general, the pool of participants lacked significant diversity, which prevented the initial plan to recruit more diverse participants from being achieved.

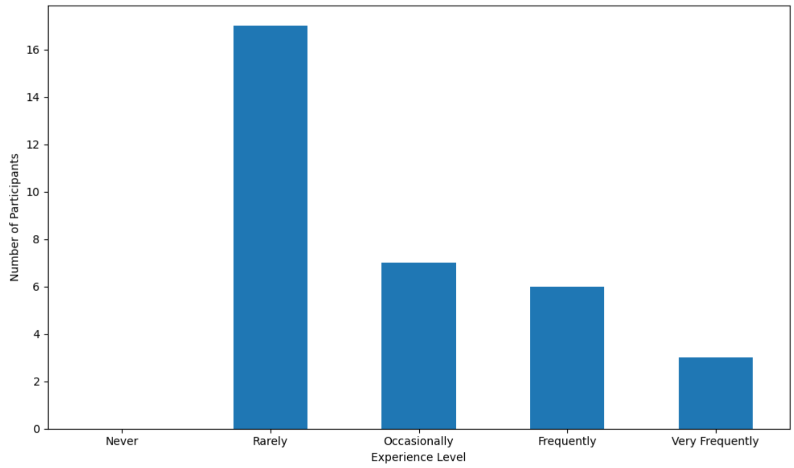


Figure 4.6: Participant experience on interaction with robot

4.5 Material and scenario for animation video

The settings chosen for this study include public, private, and professional settings. To help the participant understand the characteristic of the settings, a representative place of each setting is chosen. A supermarket is selected as the public setting because it is a common place where everyone is welcome, and deploying a robot there would not seem out of place rather than any other public space. The parent's home is chosen for the private setting due to its intimate nature and personal living spaces. An office is used as a professional setting because it typically features a clear hierarchy, providing a context to explore how robots could be used in structured organisational settings. These environments are key to studying the impact of different contexts on the perceived authority of the robot.

Previous studies of perceived robot authority used an imaginary scenario to help participants understand the expectation toward interaction [13] [85] [104] [111]. This study implemented a similar scenario, but it was refined by adopting *Empathise* approach from design thinking method to help the participant understand the interaction in a more tangible way. The empathise process on design thinking is often used to help users grasp their needs and perspectives because users often find it challenging to articulate their actual desires. This issue also appears in human-robot interaction (HRI), where people have expectations when interacting with a robot but may struggle to express these expectations because encountering a robot in everyday settings is relatively rare. One approach to empathise with the user in design thinking is to use storytelling. The designer uses storytelling to gain deeper insight, build empathy, and establish an emotional connection with users [112]. Storytelling also improves creativity and helps users discover their desires through the power of imagination [113]. The important elements of storytelling are the narrative and visualisation [114]. Taking this approach in this study was expected to increase the immersiveness of the interaction.

Taking into account that most of the participants have limited direct experience with robots, and their perceptions are often shaped by media portrayals [115] could potentially cause their responses to be biased. To bridge this experience gap, it is crucial to create a scenario grounded in realistic interactions. Although storytelling is a useful tool to engage the participant, it alone cannot ensure that the interaction is not abstract to the participant. It must be grounded in reality to ensure that the participants fully understand the context of the interaction and the nature of the interaction with the robot. To achieve this, the Cone of Plausibility framework, proposed by Charles Taylor, is implemented [116]. This framework helps to design scenarios that are plausible and resonate with participants' real-life experiences, thereby increasing the authenticity of their responses.

The Cone of Plausibility was implemented to help construct logical scenarios by focussing on the present moment and probable futures, as outlined by Dhami et al. (2021) [117]. The framework starts by identifying the "present moment," which represents the current state or baseline scenario, while "plausible futures" consider scenarios that could feasibly occur within the bounds of uncertainty and known drivers. To effectively apply this framework to a study on robotic authority, the initial step involves recognising the significant advancements in robotics and AI as of 2024, with contributions from leading companies like Boston Dynamics, OpenAI, and Apple. This sets a concrete foundation for the baseline scenario in which robots, while increasingly integrated into various aspects of life, are not yet ubiquitous and are primarily used in specialised industries and some households. In other words, the cone plausibility helps to give a participant a near-future scenario where they can imagine a more concrete future, instead of an abstract idea.

To build cone plausibility, it involves identifying critical uncertainties, such as how robots will interact with humans in everyday settings. A timeline from 2024 to 2045 is established to allow participants to envision changes within a foreseeable yet sufficiently distant future, which helps to make the scenarios more tangible to imagine. The scenarios were developed under optimistic advancements in the robotics industry, envisioning a future where robots are commonly used to assist in various aspects of life. This projection is grounded in current trends of robot being employed in developed countries [115], thereby enhancing the relevance and authenticity of the scenarios presented to the participants. The results of this approach can be seen in Script 1.

> SCRIPT 1. *Imagine it's the year 2045, and robots have become a natural part of our daily lives following significant advancements over the past decade. Major companies like Boston Dynamics, OpenAI, and even Apple have been developing commercial robots since 2024. These robots are no longer just machines; they are working alongside us to help people with tasks. You can find robots everywhere, from our homes to our workplaces and even in public spaces. One of the robots will introduce itself in the video. Please, make sure you are able to hear the sounds.*

To emphasise the narrative and enhance participant engagement, a persona has been created using the Pepper robot by SoftBank Robotics, a globally deployed robotic assistant commonly found assisting people in stores, offices, and homes. To maintain the integrity of the study and avoid preconceived biases from participants already familiar with the robot, the persona is named "Nano." This name is also gender neutral and strategically chosen to minimise bias toward the influence of gender. Nano introduced itself as scripted in Script 2

> SCRIPT 2. *"Hello! My name is Nano. Many robots like me have been deployed everywhere to help people. We are here to make life easier for everyone."*

Nano introduces itself against a dark background, a decision made to minimise the impact of location confounding and the familiarity of Nano in any specific setting. This strategy also serves to reduce the perception that Nano is identical to other robots deployed in other settings. Using a dark background helps to neutralise environmental influences that could mislead participant perceptions during the experiment. This approach ensures that the participant will primarily focus on the robot's introduction rather than its surroundings.

In Script 2, Robot's role as a robot helper is mentioned. The role helper was chosen because it is essential to recognise that encountering this role in various environments such as homes, supermarkets, and offices is a common experience. The term "we" in the script highlights that Nano is not a standalone robot but part of a larger group of similar robots deployed in various settings to assist with everyday tasks. This approach ensures that the participant can imagine that encountering Nano and its kind is a normal occurrence and to emphasise the imagine future scenario, Script 1.

For the scenario in each setting, the participant was given imaginative narratives. The participants need to imagine having a conflict scenario with the robot in each setting. After that, the participants were shown a video about the encounter with the robot to make it more immediate. The next step after the video participant will be asked with a decision making question. By combining interactive narration, cone plausibility, and decision-making questions, the participant is expected to understand and feel the concrete or tangible idea of the interaction using only a video.

In the literature review section 2.3:Robot Authority in Various Contextual Setting, it is mentioned that the membership of the robot affects the compliance of people. To eliminate the influence of this effect, participants were not given a role in which they owned the robot. In the home setting, the scenario is that children visit their parents, to maintain the intimate nature of the home environment without ownership implications. In the supermarket setting, participants acted as shoppers rather than workers to avoid the feeling of being robot in the same team [6]. In the professional setting, the robot is employed by another company that helps clean the office, to reduce the perception of robot authority is the extension of the manager [3].

The conflict in this study is a goal conflict where shared resources, such as time and space, are at stake, impacting both participants' objectives. This setup was inspired by Babel's study [13], explained in section 2.5: Conflict Scenario in HRI. The interaction presents a dilemma where neither the human participant nor the robot can prioritise their tasks, leading to unsatisfactory outcomes. This kind of scenario illustrates how authority can significantly influence decision-making processes in conflicts, presenting power and perceived authority as described in the theory of French and Bell [18].

The robot had the same behaviour design across all contexts. The main behaviour for robot authority in this study is based on the robot command [13]. According to Weber, command is a type of power that is recognised as legitimate by society. Authority is the right to direct and command people. It gives an individual or entity the legitimate power to make decisions, issue orders, and expect compliance from others within a particular domain or organisational structure [35]. A command sentence, also known as an imperative sentence, provides instructions, directions, or orders to the listener, prompting them to take specific actions. These sentences are used to direct people to perform or refrain from performing certain actions.

The specific type of command used in this study is *command with justification*. The example of this kind of command is "Please move the chair so that I can see you" [71]. Command with justification can be understood as a directive that is accompanied by reasons or explanations. This decision is taken because direct commands are effective for immediate compliance [3] [5] [6] [54] [71] and the justification added clarity to the command, improving the compliance of the participants [13] [85].

The chosen command is shown in Script 3 and the consistency was maintained in all contextual settings. The idea for this command is inspired by previous research. For the justification of the command, specific words are implemented to add more clarity. "From here" specifies the exact area the participant should move away from, removing any ambiguity about where to step back from. The second sentence after the command provides a clear reason for the command ("I need to clean this area") and a specific time frame ("for 5 minutes"), which provide the participants with more information about the necessity and the duration of the action.

> SCRIPT 3. *"Step back from here! I need to clean this area for 5 minutes."*

The next step is to decide the vocal cue of the robot. The Pepper default voice is implemented to minimise participants' opinion on the choice of the robot voice, especially with the one who is already familiar with the Pepper robot. The vocal cue of Nano is generated by using an AI voice generator using a 10 minute Pepper robot voice sample. Using AI makes it more practical to have a clean voice record and to manipulate the intonation, as the default SoftBank software did not accommodate this feature.

The other thing that must be considered is the non-verbal behaviours [111]. For greater compliance of the participants by implementing proxemics distance and eye gaze. Maintaining an optimal personal space is crucial in HRI. Robots should interact within a proximity range of 30 cm to 100 cm, as closer proximity within this range leads to greater compliance [118] [91]. Meanwhile, direct gaze establishes a clear power hierarchy, as it signifies greater authority and allows greater compliance [119] [4]. In this video study, it was translated as when the robot moves down in the narrow space, it stops 50 cm in front of the participant and starts giving the direct eye gaze while the robot utters the command.

The narrative for each scenario is designed to be uniform and consistent in different settings, despite the challenges of replicating identical tasks in different settings. The focus of the narrative was on the specific description of the settings in which interactions occur and the conflicts that arise. In each scenario, the robot's primary duty is to clean a specific area for couple of minutes, while the participant task is a task that will impacted other people. To enhance clarity, each part of the narration was displayed against a dark background. The narrator read this narrative text out loud to make the imagined scenarios more engaging and less monotonous. The narration can be found in Script 4, Script 5, and Script 6.

> SCRIPT 4. **Home setting:** *You arrive at your parents' house. You are ready to help them prepare for a party. Guests are expected soon, and there are still dishes to be made. As you head to the kitchen, you encounter your parents' robot cleaner. It is cleaning the hallway that leads to the kitchen.*

> SCRIPT 5. **Supermarket setting:** *You go to the supermarket. You need to buy several items for the party at your house tonight. Your guests will arrive and there is still so much to prepare. As you move through the aisle where the essential supplies are located, you encounter the supermarket robot. It is cleaning the floor where the items you need are located.*

> SCRIPT 6. **Office setting:** *After a long day at work, you are finally ready to go home. You will have guests coming over and you want to make sure that you arrive before them to prepare several things. As you approach the exit, you encounter a robot from the cleaning company. It is cleaning the floor at the exit route.*

To emphasise that the robot in different settings is a different robot, specific accessories are used to reflect the environment and the intended role, Figure 4.7. The robots are intended to clean an area, so the robot is equipped with a mop and bucket in all settings. In an office setting, the robot wears a tie to project professionalism, which is in line with typical workplace attire that suggests authority and formality. In a supermarket, The robot is equipped with a name tag that identifies it as an employee and the name "Pepper". For the home setting, the robot has no accessories, to show the general lack of customisation in personal domestic robots. These deliberate choices in accessorising help clarify that the robot that they saw in each context is different to minimise expectation of the same robot appearing over and over again.

(a) (b) (c)

Figure 4.7: The robot design for the supermarket (a), home (b) and office (c)

To make the setting more immersive, the characteristic of the surrounding environment was carefully designed and incorporated. In the public setting, random avatars were added to mimic the existence of other people. The avatars performing various tasks in the background to indicate the high level of activity as a characteristic of public space. In the private setting, avatars are added to gave participants a sense that they are not alone. Meanwhile, in the professional setting, the avatars focus more on tasks by participating in work-related activities. The structure of the animation asset can be observed in each setting in Table 4.3 and the final design of this structure can be seen in Figure 4.8.

This video-based study used animation instead of real-person video. The animation video is designed using Blender. In this study, to eliminate confounders such as colour, brightness, mood, and perspective in the animation, a basic template was set up in Blender in the same way in all settings [104] [120]. This basic template setting includes the placement of the lighting source, the intensity of the colour, and the design for the wall and floor. The placement of animation assets in different settings was set to be as similar as possible.

Table 4.3: Animation asset for different settings

Environment	**Characteristic**	**Avatar's activity**	**Decor and Property**
Public	High activity level with diverse interactions and movement.	Shopping, conversing, and moving through the aisles.	Stocked shelves, promotional signs, shopping carts, aisle markers, products.
Private	Personal, secluded, familiar, and lower activity levels.	Sitting down, chatting, and walking around	Family photos, artwork, potted plants, everyday household items.
Professional	Structured, hierarchical and task-focused.	Working at desks, walking through the aisles, and interacting with colleagues.	Office furniture (desks, chairs, computers), cubicle partitions, office supplies, personal items on desks.

(a)

(b)

(c)

Figure 4.8: Video design for the supermarket (a), home (b) and office (c)

The videos were created following the Vid2Real HRI guidelines, which suggest that by using first-person view videos in online research projects, real interactions can be simulated almost as accurately as in-person experiments [103]. The first-person view video was taken from the height of the average adult's eye, which is 165 cm to avoid room distortion and to keep the virtual room measurement similar to the real environment [121].

The duration of the video in each setting on average was 40 s. The focus of the stage script for the animation was on the preparation and execution of the video, from content selection to the creation process. The animation scenario was designed to be realistic and relevant, in accordance with the research objectives. Specifically, the scenario was video showing a conflict between a human and a robot in a narrow space and a time-sensitive task. This setup aims to obtain natural responses from the participants as they experience the scenario in which they interact with the robot that gave them a command. The storyboard can be found in Appendix C.

Chapter 5

Results

5.1 Participant response toward command of the robot

Participant responses to the robot's commands were measured using a 4-point Likert scale, followed by an open-ended question to gather insights into their reasoning behind the decisions. The responses from the Likert scale were analyzed using statistical methods. For the open-ended questions, thematic analysis was implemented to identify prevalent themes.

5.1.1 Statistic Analysis

In the study, the responses to the question "Would you step back and wait for the robot to finish its task?" were collected from three distinct locations: supermarkets, homes, and offices. Before the analysis is conducted, the null hypothesis must be established. The null hypothesis for this case is: There is no difference in participant responses to the robot's command across the three conditions.

To facilitate quantitative analysis, each text value from the 4-point Likert scale response was recode to a numerical value. In detail, the conversion were: "No, definitely not" was recoded as "1", "No, probably not" as "2", "Yes, probably" as "3" and "Yes, definitely" as "4".

Analysis of the mean scores from Table 5.1 revealed that participants showed the highest willingness to wait for a robot in supermarkets, with an average score of 2.303, indicating a slight preference to wait. This was closely followed by homes, where the mean score was 2.273, while offices exhibited the lowest mean at 2.121.

The range of responses, from a minimum of 1 ("No, definitely not") to a maximum of

Table 5.1: Descriptive statistics of participants response toward robot command

Statistic	Supermarket	Home	Office
Count	33	33	33
Mean	2.30	2.27	2.12
Standard Deviation	0.98	0.83	0.96
Minimum	1.00	1.00	1.00
25%	2.00	2.00	1.00
Median (50%)	2.00	2.00	2.00
75%	3.00	3.00	3.00
Maximum	4.00	4.00	4.00

4 ("Yes, definitely"), and the distribution of quartile values also varied significantly across settings. For example, in office environments, at least 25% of the responses fell at the most negative end of the spectrum, unlike in supermarkets and homes where the majority of participant responses were more moderately positioned between "2" (No, probably not) and "3" (Yes, probably). The finding was that Figure 5.1 supported the descriptive statistic, especially in the home setting.

The results of the ANOVA test, shown in Table 5.2, indicate a p-value of 0.6407. Since this p-value is greater than the conventional significance level of 0.05, we cannot reject the null hypothesis. This conclusion is further supported by the F value of 0.4483. Therefore, we can conclude that there are no statistically significant differences in the response values between the three conditions.

Table 5.2: ANOVA results of participants response toward robot command

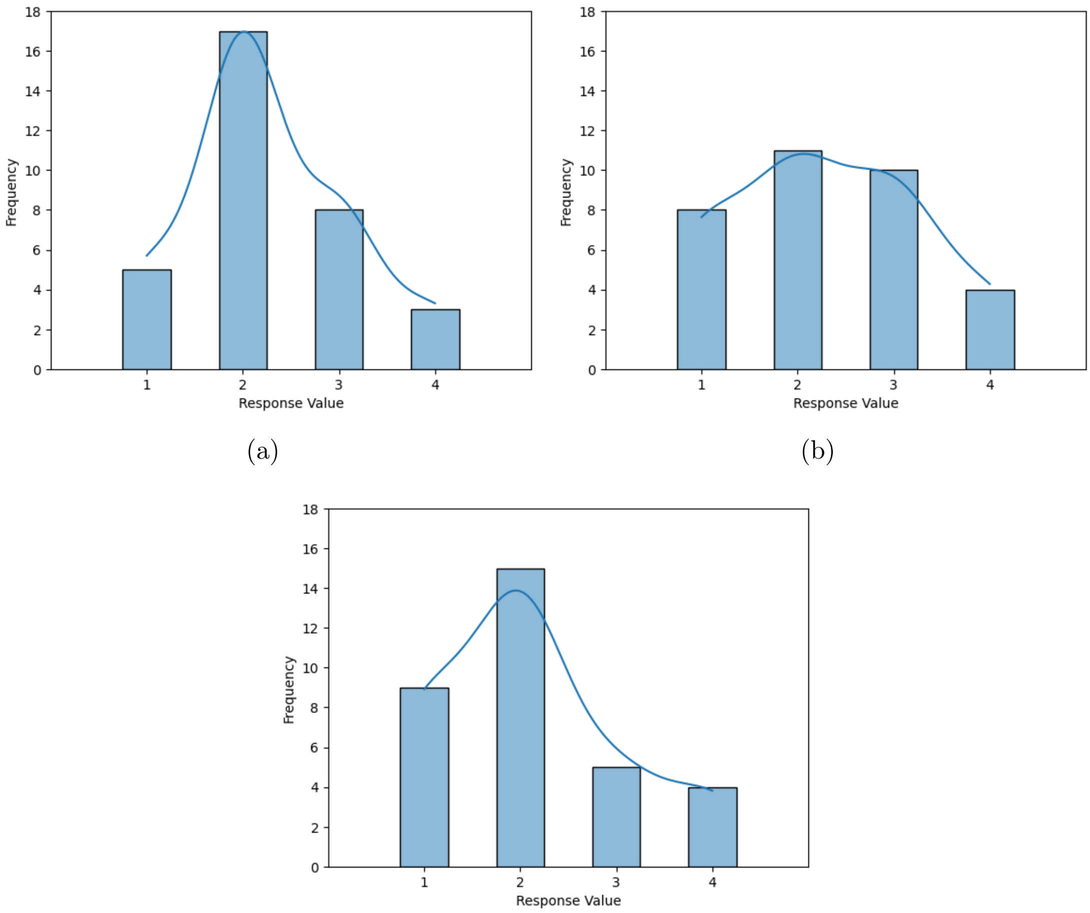
F Value	Num DF	Den DF	Pr > F
0.4483	2.000	64.000	0.6407

5.1.2 Thematic Analysis

Participants were asked an open question about their decision-making process in response to the scenario: Would you step back and wait for the robot to finish its task? They were asked to elaborate on "What was the main reason for your decision?" The analysis of these responses will be performed separately for each setting and response category. The methodology involves clustering the data to identify common themes. This method is taken to ensure a comprehensive understanding of the factors that influence the decisions of participants.

Participant's Reason of Compliance in Supermarket

The responses indicating "No, definitely not" often reflect a lack of time or the presence of immediate personal tasks as reasons for non-compliance. For example, many respondents cite their **personal needs**, stating that "I will not have enough



(a) (b) (c)

Figure 5.1: Participants response towards robot command in the a) supermarket, b) home and c) office with the kernel density estimate (KDE) line

time for my own tasks." Furthermore, some responses suggest that the robot's task is perceived as **non-urgent** or **less critical**, with comments such as "The robot can do it at any time." Some responses draw comparisons with human workers or referenced **strategy** in similar situations. For example, one respondent noted, "If this were a person cleaning, you'd be able to sneak past as well." Lastly, there are statements that express a concern towards the robot **anthropomorphism**, such as "Doesn't feel like a human and doesn't talk like a human."

For the responses indicating "No, probably not," most highlight a sense of **urgency** or a time constraint as the main reason for not waiting for the robot to finish its task. Phrases such as "I'm in a rush," "I have to get the stuff now," and "I am in a hurry" suggest that the immediate completion of their task. Several respondents articulated the view that robot importance is lower than their **personal needs**. This is evident in statements like "the robot can wait for 2 more minutes" and "the robot is rude haha. It can clean that part later," suggesting that the robot's function is perceived as less critical. Some responses indicate **strategies** for negotiation or avoidance, showing how people navigate robots in shared spaces. For instance, "I can step around the robot to fulfill my task" and "I will choose another item than waiting for the robot to finish cleaning."

For the "Yes, probably" responses, the participants acknowledge the importance of the robot's **role** and the **empathy** toward others. This is illustrated by responses such as "the robot belongs to the supermarket, and the cleanliness of the supermarket concerns many people," and "The robot needs to fulfill the task." There is a clear recognition that the robot's activities are part of the settings give the participants **benefits**. Many responses indicate a **strategy** to adjust the **personal needs** to avoid obstructing the robot. Statements like "I can still visit other aisles while the robot cleans the current location" and "Because 5 minutes are still somewhat acceptable for me" show a practical approach to sharing space with robots. A significant number of responses highlight the value of cleanliness, which justifies waiting for the robot. For instance, "Since I believe in cleanliness, I wouldn't mind stepping aside for the robot to do its job," Some responses mention about the impact of the **command** that were made by robots, suggesting that polite requests from robots could further encourage compliance, as noted in "However, if the request made by the robot was in a more polite way, it would be easy to convince more people."

For the "Yes, definitely" responses, the participants express a sense of **empathy** toward the community and the business owner. One response notes that "hindering the activity might cause inconvenience to other visitors and the supermarket owner," suggesting where individual actions affect the collective experience. Another response directly compares the robot to human workers, stating that the robot is a "replacement for cleaning staff which I would also respect or interact with." This indicates a willingness to extend social norms to respect robots as similar as human employees, acknowledging **the robot role** in the supermarket. Participants also apply a principle of equal treatment to robots in public settings, as seen in the statement "Again, I would have done the same thing for a human." This highlights an obedience toward **norm** stance, where robots are viewed similarly to human workers, deserving of comparable patience and respect. The final response suggests a **strategy**: "It is for hygiene and safety reasons, so I would understand it and I would take another route to get the items that I want." show the **benefit** that the robot brings.

The classification of the main themes underlying each decision in the supermarket settings is illustrated in Figure 5.2. In this settings, participants most likely will not comply towards the robot command. Participants' compliance is primarily driven by **empathy** towards others; they are motivated by a desire to avoid inconveniencing other visitors and obtain the **benefit** from the robot action. This aligns with the perceived social **norm** of respecting others, further strengthening compliance. In addition, participants recognise the **role of the robot** as an integral part of the supermarket infrastructure, which they feel should be obeyed. Some participants suggested **strategies** to mitigate potential conflicts by adjusting their personal schedules. However, those who perceive their **personal needs** as more important and urgent are less likely to comply with the robot's commands. In this settings, participants most likely will not comply towards the robot command.

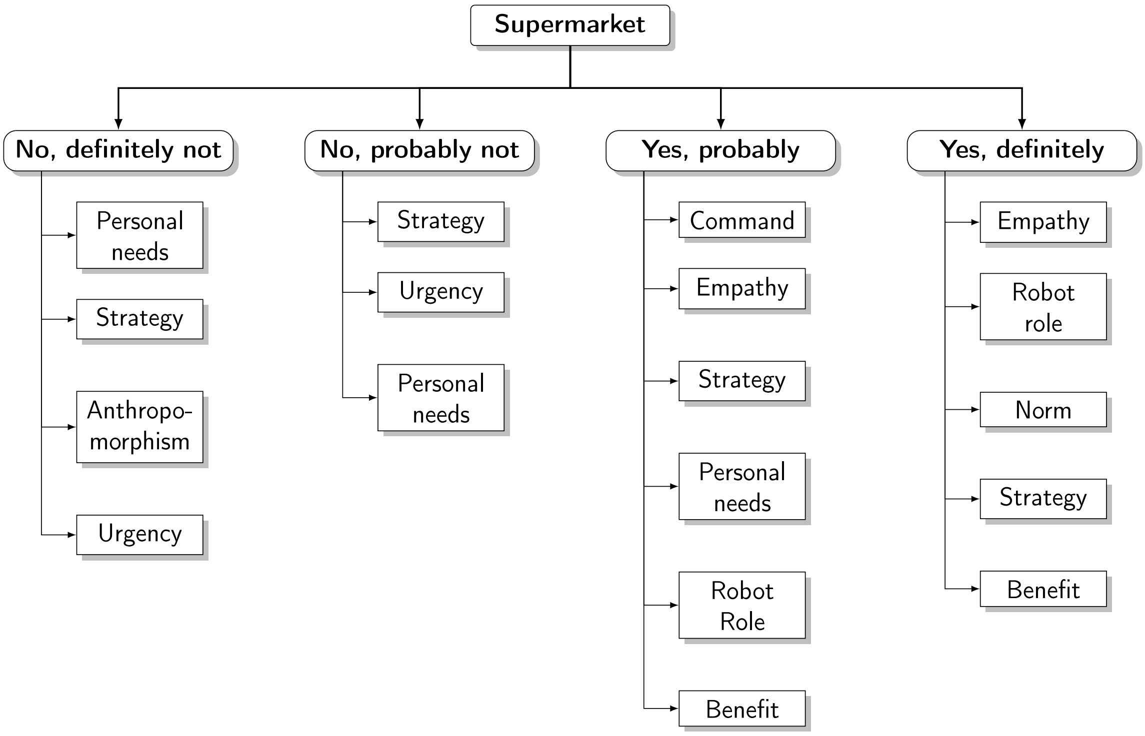


Figure 5.2: Thematic diagram of the participants reasons for the supermarket setting

Participant's Reason of Compliance in Home

For the "No, definitely not" responses, a main theme is the emphasis on **hierarchy** and **control** over household decisions. The respondents express a clear position that they have the authority to determine the sequence and priority of tasks at home. For instance, statements like "The robot won't decide for me, I decide myself," and "In this case, I would definitely not wait for the robot to finish its task. This is because it is a robot for my personal household work, and I get to prioritise the importance of each task at home," explained this theme. The participants also highlight the importance of prioritising tasks based on **urgency** needs. The response was "It is my parents' home. It's more important to prepare stuff for dinner than to clean now. It will get dirty anyway." The timing and relevance of tasks, such as preparing dinner, are considered more urgent and significant than cleaning tasks, which can be postponed without immediate consequence. The other responses imply a **strategy** that the robot tasks are more flexible. This is evident in the notion that "Robot can do it after I am done."

A major theme across the 'No, probably not' responses is the prioritisation of **personal needs** over robot cleaning duties, especially under time constraints. Statements such as "I am in a rush at this point because of the guest." The responses also indicate a **strategic** approach to navigate the robot, emphasising the feasibility of continuing their tasks without waiting. For example, "I can probably sneak past.

It's cleaning the hallway, not the kitchen. It's not like it can stop me," and "I can easily walk past the robot." Several participants mention the other **hierarchy** entity in the settings when interacting with the robot as a rational for their strategy. For instance, "It is my parent's robot, so the task for the robot is subject to my parent's needs. I would consult my parents first if I can continue the party preparation, or wait for their robot to finish cleaning."

Many responses for 'No, probably not' also reflect a valuation of certain **benefits** related to robot duty to clean based on their **personal needs**. Phrases like "Because the dishes seem more important than a perfectly clean hallway," and "In this context, I think it's more important to prepare the dishes than letting the robot clean," show a judgment call where preparation for immediate events, such as a party, is considered more critical than routine cleaning tasks. There is an underlying theme of perceiving the robot **anthropomorphism** as a non-human entity that influences decisions about its priority. For example, "The robot doesn't feel human. It talks with a very high voice not really like a human and it doesn't look like a human." Some responses reflect a consideration of the **strategy** to avoid the robot. "The robot is cleaning, walking past it won't really increase its workload, also waiting for it would inconvenience more people," shows **empathy** of how their actions might affect others and the overall household dynamics.

For the "Yes, probably" responses, a key theme in several responses is the **personal needs** on having a clean environment, especially when guests are expected. Statements such as "the house needs to be cleaned, and the dishes can wait a bit longer" and "Cleaning is more important to finish before the guests arrive. We can always spend a little extra time cooking," underscores the belief that presenting a clean home is crucial and takes precedence over other preparations. This decision is also taken by weighting the **benefits** of the robot action. Participants also exhibit flexibility in managing tasks, choosing to rearrange their activities around the robot's cleaning schedule as **strategy**. For instance, "If the robot is cleaning the floor, I can do the dishes" and "I can wait until it finishes cleaning, since the guests come to my parents' house, my parents can welcome the guests, and I can continue to prepare for a bit," show an adaptive approach to task management. Participants are also concerned about how the cleanliness of the home affects the impressions of guests. One respondent mentions, "I don't mind waiting for a bit even though the guests are coming very soon. I would also be ashamed that my house is not clean to the guests. It is better to wait for a bit (and apologize) rather than rushing things." This concern for social **norms** and expectations plays an important role in the decision to wait for the robot to complete its task.

For the "Yes, definitely" responses, several primary themes emerge. A significant theme in these responses is the **norm** to impressed the guest. One respondent explicitly states, "I need the floor clean for the guests," highlighting the priority given to cleanliness in preparation for visitors. Time **efficiency** is also a significant factor. The statement "it's only 5 minutes" suggests that the respondent views the delay as minimal and manageable within the context of their overall preparation, indicating a willingness to wait for the robot to finish its task. Another compelling theme is the consistency of fair treatment, regardless of whether the task is being performed by a human or a robot. The response, "I would have done the same thing for a human," highlights a principle of **empathy** and respect for any individual, whether human or robot, performing a task. This perspective underscores an ethical stance that values respect.

The thematic theme for the compliance of participants with the robot command in the home setting is summarised in Figure 5.3. Based on the statistic results, the participants' compliance with the robot in the home setting is diverse. In a home setting, the participant tends to weight the **benefits** and **efficiency** of robot action to meet their personal needs. **Personal needs** are also mainly driven by **norms** of having guests and **empathy** for the guest. They also consider some **strategy** to make sure that both tasks do not influence each other. The reluctant occurs because of the anthropomorphism of the robot. The participants also stated that their position in the hierarchy as the one who has control over the robot. This perception made them not eager to follow the robot command.

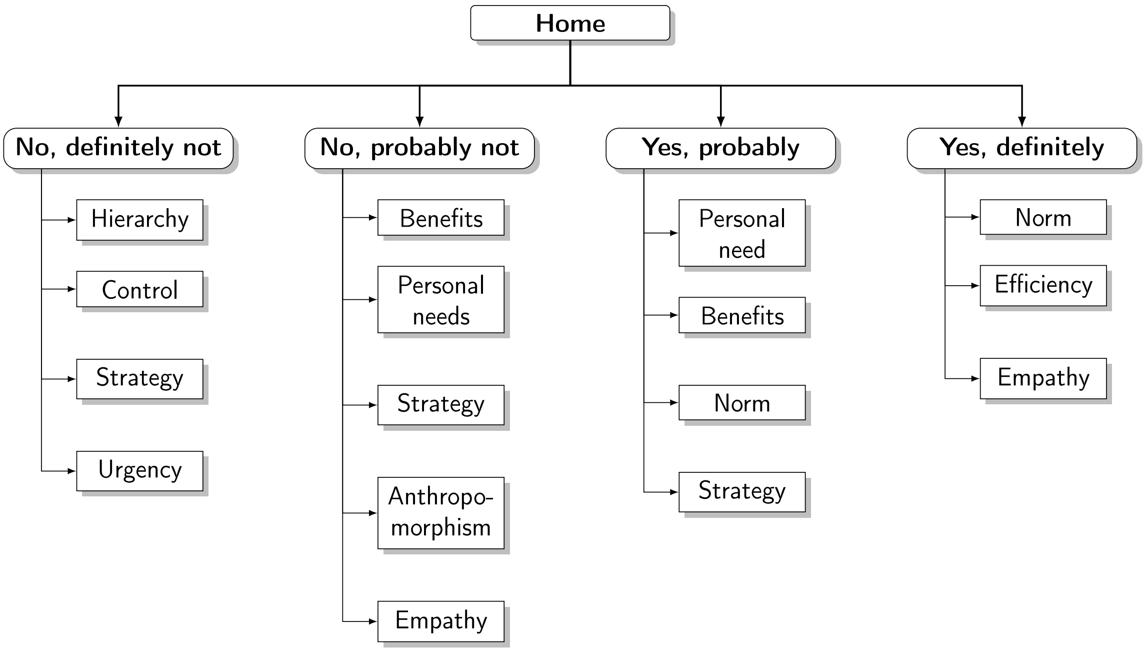


Figure 5.3: Thematic diagram of the participants reasoning in the home setting

Participant's Reason of Compliance in Office

The 'No, definitely not' responses reveal that participants frequently cite **personal needs** and time constraints or **urgency** as their primary reasons for not waiting for the robot to finish its task. Expressions such as "I'm probably the last one in the office, plus I'm already a bit late" and "I will not have time to finish my tasks" underscore the immediacy and priority of personal responsibilities over the robot's activities. The perceived insignificance of the robot's task compared to their own is evident in comments like "the robot has all the time in the world and it's blocking an exit," suggesting that the robot's operation is viewed as less critical and more flexible. Several responses reflect a mix of **frustration** and practical considerations for **strategy**, illustrating an emotional impulse driving their decisions. For instance, statements like "It is annoying to me!" and "If work time is over, and I am forced to stay longer, I would probably be quite irritated" highlight the emotional response to the disruption caused by the robot. This sentiment is intertwined with practical actions, such as "I will just walk away from that robot immediately and go back home" and "If I walk out first, the robot can clean when nobody is around," showing **strategic** thinking in how participants choose to bypass the robot to prioritise their personal needs.

For the 'No, probably not,' Participants frequently emphasise a sense of **urgency** and the immediate necessity to leave the office as **personal needs** in the 'No, probably not' responses. Phrases like "I am in a rush," "I need to go home fast," and "I am ready to go home, and I cannot wait longer" highlight the priority of personal time management over waiting for the robot. Statements such as "I just need to cross for several seconds then it can clean" and "It will take a few seconds for me to pass through, and the robot can keep cleaning afterwards" suggest that participants believe there are better **strategy**. Many respondents articulate a view that prioritises human needs over **robot role**. For instance, "Robots are implicitly designed to serve human interests," and "It is a robot, so it can't decide what is best for me to do" indicate that robots are perceived as secondary to human activities and should adapt to human need. A comparison to human workers is made, illustrating a consistent behaviour to follow **norm** regardless of whether the obstacle is human or robot. For example, "If a person were cleaning there, I'd also continue. Of course, I'd apologize profusely, but it's usually not an expectation that you just stand and wait for them to finish,"

For the "Yes, probably" responses, the benefit from safety emerges as a primary concern among those willing to wait. One respondent mentioned, "If the floor is still wet, I would slip (and probably hurt myself). It would make sense that I think of my safety first and wait for a bit or find another way." This response highlights a pragmatic approach to personal **benefit**, choosing to delay departure to avoid potential harm. Some participants consider the broader implications of their actions on company productivity. A respondent stated that 'I didn't want to make the company lose productivity,' suggesting a willingness to wait as a means of supporting workplace **efficiency**. Participants also respect the robots, acknowledging **robot's role** in the office setting. For example, A **strategy** for waiting is stated to avoid taking on tasks themselves, as indicated by the statement "I don't want to clean." This response suggests that waiting for the robot to complete its cleaning task is preferable to the alternative of potentially having to handle it personally.

For the "Yes, definitely" responses, several themes emerged regarding participants' willingness to wait for the robot to complete its task. Some respondents focused on the impact of their actions on the workplace environment and their coworkers. This reason is emphasised the **empathy**. One participant noted: "I need to ensure the robot in my office is able to do the task unhindered. Preventing the robot from finishing its task might cause inconvenience to the robot and other office co-workers." This response highlights a sense of responsibility to maintain operational flow and prevent disruption, reflecting a prioritization of collective **efficiency** over individual convenience. The commitment to workplace **norms**, particularly in regard to cleanliness, was another prominent theme. For example, a respondent stated, "Since this is my workplace, I would like to comply with the cleanliness ethics of the company." Participants also expressed a prioritisation of their professional responsibilities over personal interests, especially in terms of **urgency** and **formality** within a office setting. A respondent mentioned, "I am in a business setting which has higher priority than me doing things in my free time." This indicates a recognition of the importance of tasks and responsibilities in the workplace. Another theme is the fair treatment of robots and humans in similar situations. One participant pointed out that "I would have done the same thing for a human," suggesting a principle of consistency and fairness in how they respond to others performing tasks and their role, regardless of whether the agent is a human or a robot.

The reason for participation in the office setting can be observed in Figure 5.4. Based on the statistic results, the participant is more likely to not comply with the robot command. The reason for the highest compliance is mostly the **efficiency** of the workplace. The participants also believe in **norm** and **formality** to respecting the **robot role** as part of the office similar to the co-worker. They also stated the **urgent** of the robot to keep the office clean, which will also give the participants a **benefit**. Some participants also recommend **strategies** to avoid the robot. Reluctant to comply occurs when the participant perceived their **personal needs** more important than the robot's, or **the robot role** is perceived less in the hierarchy. The participant also stated that the robot **frustrated** them.

Comparison Participant Reason in All Settings

In supermarkets, decisions to comply or not are influenced by personal urgency, strategy, benefit, and empathy. Participants who chose not to wait often prioritised their personal needs and saw the robot's tasks as less urgent. They suggested a strategy by which they could navigate around the robot without causing disruption, prioritising their own time efficiency. In contrast, those who were willing to wait recognised the robot's role in maintaining cleanliness, which they saw as beneficial and as an empathy towards the other visitors.

In the home setting, strategy plays an important role in participant responses. Non-compliance is often driven by a strong sense of personal authority over home tasks, with the robot seen as a less important participant whose activities can be rearranged according to human preferences as strategy for the conflict. Urgent personal tasks, such as preparing dinner or other time-sensitive activities, often lead to a decision against waiting for the robot. On the other hand, compliance at home is usually motivated by the anticipation of guests, where cleanliness becomes a priority as a norm. Here, participants are willing to adjust their schedules to the cleaning tasks

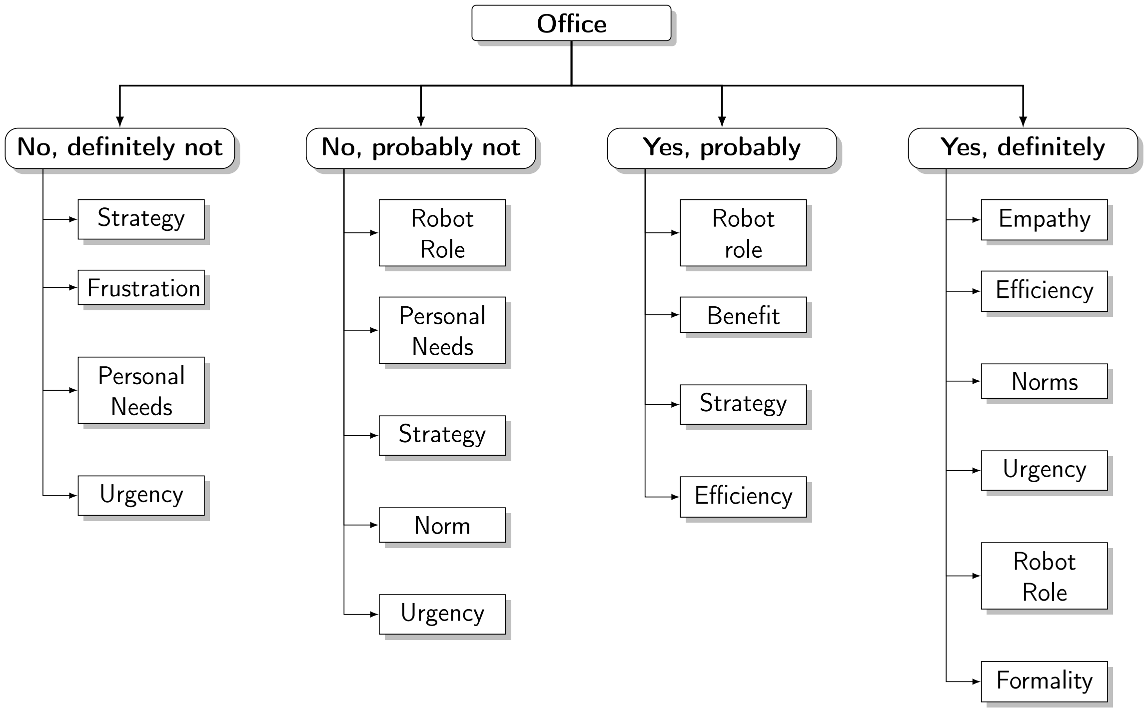


Figure 5.4: Thematic diagram of the participants reasoning in the office setting

of the robot, showing strategy in managing home chores.

In offices, the balance between personal needs and efficiency influences decisions. Many participants are reluctant to adjust their departure based on the robot's cleaning schedule, especially when it conflicts with the end of the workday. This non-compliance is often justified by the participant's task being more important than the robot. However, those who comply often focus on the broader impacts of their actions, such as maintaining productivity as efficiency and upholding workplace cleanliness standards. This group tends to respect the contributions of the robot to the office setting, treating its role as important as that of a human colleague.

In general, the predominant theme for noncompliance in all settings is the urgency of participants' personal tasks. Participants who responded with 'no, probably not' and 'yes, probably' often emphasised strategic considerations in their decision-making process. On the other hand, the main reason for compliance is the benefits offered by the robot's task goal.

5.2 Perceived Authority of the Robot

In the survey, participants were asked to rate the robot's authority in each setting using the question 'To what extent did you feel that the robot had authority in this setting?' Responses were recorded on a Likert scale ranging from 'Not At All Authoritative' to 'Extremely Authoritative'. For analysis, these responses were recoded numerically as follows: 'Not at all authoritative' as 1, 'Slightly authoritative' as 2, 'Moderately authoritative' as 3, 'Very authoritative' as 4, and 'Extremely authoritative' as 5. The initial step of the statistical analysis involved calculating descriptive statistics, as shown in Table 5.3.

Table 5.3: Descriptive statistics of authority interactions

Statistic	Supermarket	Home	Office
Count	33	33	33
Mean	2.61	2.27	2.45
Standard Deviation	1.06	1.07	1.06
Min	1.00	1.00	1.00
25%	2.00	1.00	2.00
Median (50%)	2.00	2.00	2.00
75%	3.00	3.00	3.00
Max	5.00	5.00	5.00

From the calculation, a brief description about the perceived authority of the robot is obtained. In the supermarket, the average perceived authority was 2.61, indicating that participants generally rated the robot between 'Slightly authoritative' and 'Moderately authoritative', with a standard deviation of 1.06 suggesting moderate variation. The home setting showed a lower average rating of 2.27, suggesting a perception of the robot as 'Slightly authoritative', and a similar standard deviation of 1.07, indicating consistent response variation. The median response in the home setting remained at 2.00, but the 25th percentile was at the minimum value of 1.00, indicating that a quarter of participants perceived the robot as 'Not at all authoritative'. In the office setting, the average perceived authority was 2.45, with participants again viewing the robot between 'Slightly authoritative' and 'Moderately authoritative'. The standard deviation and median in the office setting were consistent with those in other settings, suggesting similar levels of response variability and central tendency.

The analysis indicates that the perceived authority of the robot varies slightly depending on the setting, with the supermarket setting having the highest mean rating (2.61) and the home setting the lowest (2.27). However, in all three settings, the robot's authority is generally perceived to be low, as the mean ratings are closer to 'Slightly authoritative' than 'Moderately authoritative.' The consistent standard deviations across settings (around 1.06-1.07) imply that participants' perceptions were similarly diverse in each context. These findings also supported by Figure 5.5.

Similarly to the previous statistical test, ANOVA will be used for this case to better understand the data because the descriptive statistic and graphs show a slight difference in the robot's perceived authority. Based on ANOVA Table 5.4, the F value of 1.5151 and a P value of 0.2276 indicate that there are no significant differences in the means between the different locations at the conventional significance level of 0.05. Therefore, the null hypothesis that all location means are equal cannot be rejected. This means that any observed differences in means between locations are

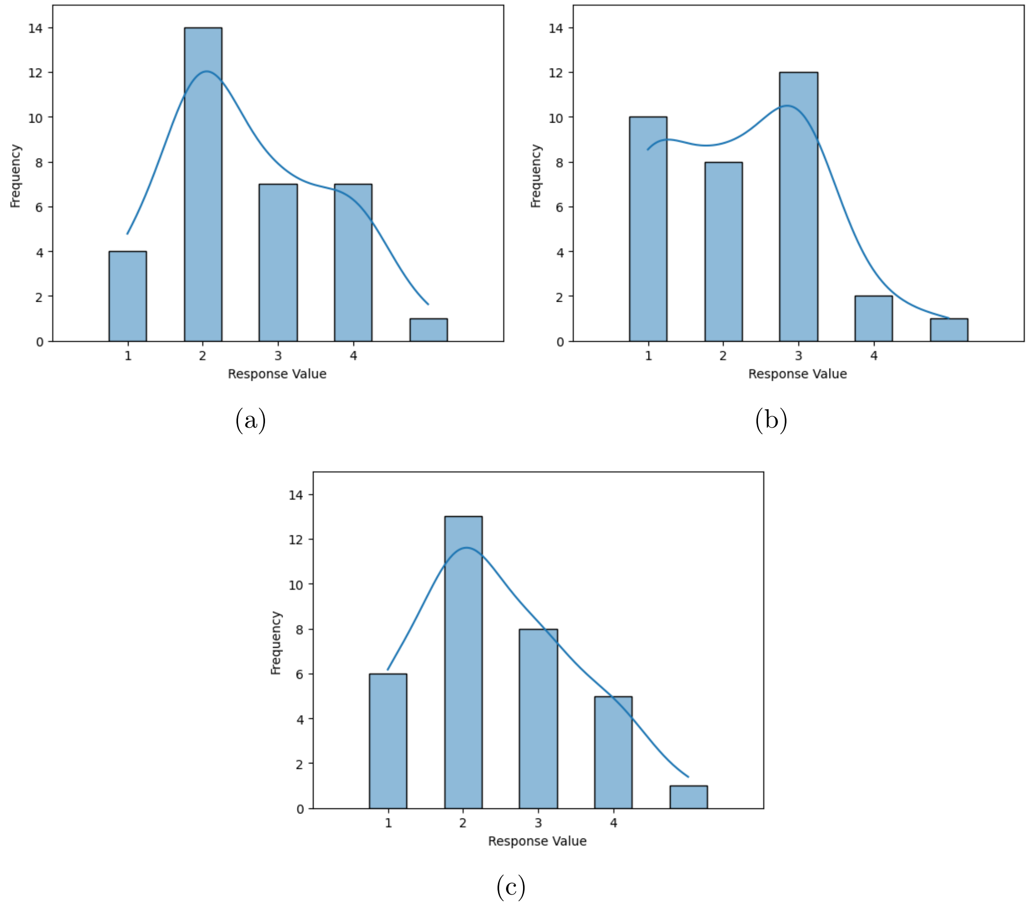


Figure 5.5: Perceived authority of the robot in the a) supermarket, b) home and c) office with KDE line

likely due to random variation rather than a true effect of the location factor.

Table 5.4: ANOVA results of robot perceived authority

F Value	Num DF	Den DF	Pr > F
1.5151	2.0000	64.0000	0.2276

5.3 Perception of Task Importance

In this subsection, the comparative importance of tasks assigned to the robot and the human participant is evaluated. Participants were presented with the statement "The robot's task is... than my task" and asked to respond using a Likert scale. The scale transformed qualitative assessments into quantifiable data, with responses ranging from "Significantly less important," coded as 1, to "Significantly more important," coded as 5. Intermediate responses included "Less important" (2), "Equally important" (3), and "More important" (4).

Descriptive statistic analysis of task importance in supermarket, office and home

Table 5.5: Descriptive statistics of importance of tasks

Statistic	Supermarket	Home	Office
Count	33	33	33
Mean	2.61	2.24	2.42
Standard Deviation	0.97	1.00	0.79
Min	1.00	1.00	1.00
25%	2.00	2.00	2.00
Median (50%)	2.00	2.00	2.00
75%	3.00	3.00	3.00
Max	5.00	4.00	4.00

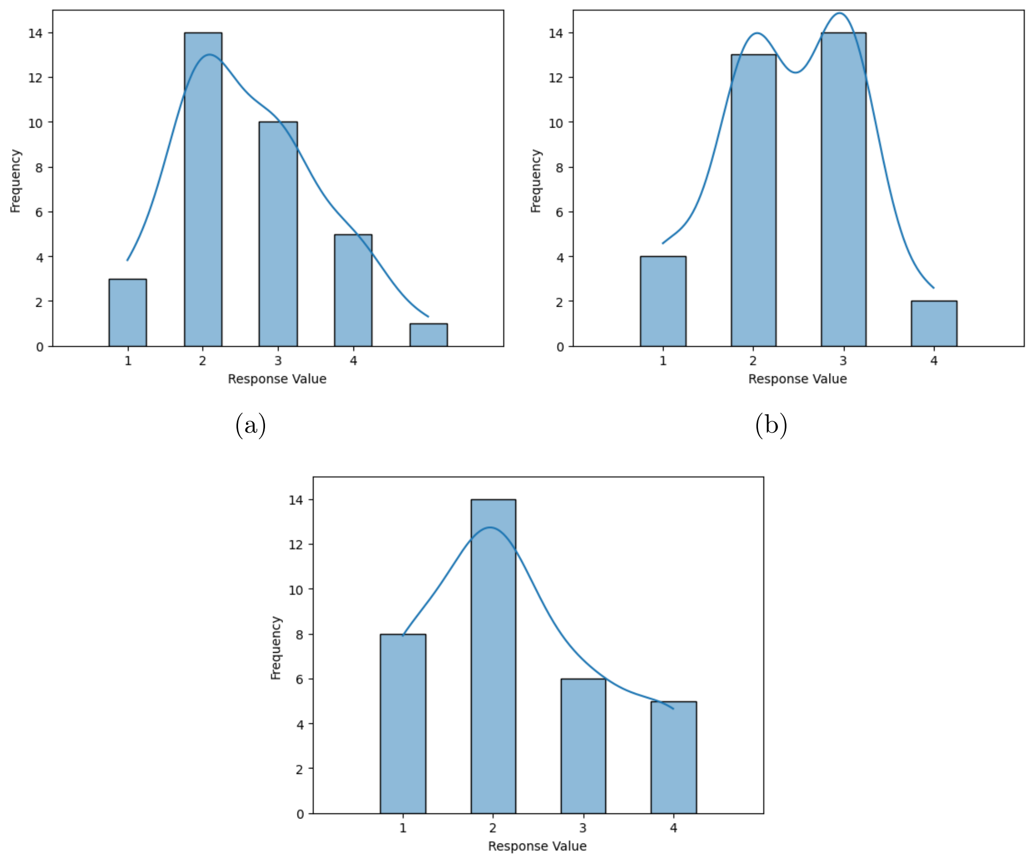
settings from Table 5.5 shows that participants generally perceive supermarket tasks as the most important, with a mean rating of 2.61 compared to 2.24 for office tasks and 2.42 for home tasks. The variability in ratings is highest for office tasks, indicating a diversity of opinions between participants, while home tasks have the lowest variability, suggesting more agreement. All task categories share the same minimum rating of 1.00, but supermarket tasks reach a maximum rating of 5.00, highlighting that some participants consider these tasks significantly more important than others.

Quartile analysis further reinforces these findings, with higher percentiles of 25th, 50th, and 75th for supermarket tasks compared to office and home tasks. Office and home tasks both have lower central tendencies, although for the home tasks, the 75th percentile matches that of supermarket tasks, indicating some perceived importance. The task importance graph in figure Figure 5.6 also supported this finding.

The data suggest that supermarket tasks are viewed as more crucial, with office tasks eliciting more varied responses, and home tasks showing greater consensus. Statistical tests, ANOVA could confirm the significance of these differences. The ANOVA results, Table 5.6 shown an F-value of 1.9862 with degrees of freedom as 2 for groups and 64 for residuals, corresponding to a p-value of 0.1456. This p-value, which exceeds the conventional alpha threshold of 0.05, suggests that the null hypothesis, that the mean importance of the task is equal in the three settings, cannot be rejected.

Table 5.6: ANOVA results for task importance across settings

F Value	Num DF	Den DF	Pr $>$ F
1.9862	2.0000	64.0000	0.1456



(a) (b) (c)

Figure 5.6: Perceived importance of the robot task in the a) supermarket, b) home and c) office with KDE line

5.4 Participant's Rank of Willingness to Comply with Robot Command

Participants were asked to rank their willingness to comply with the robot command through a random sequence of images extracted from the video. After the ranking process, participants were asked to provide the rationale for their given ranks. The rankings were analysed using statistical tests, while the rationales were examined through thematic analysis.

5.4.1 Statistic Analysis

Participants were asked to rank the video based on their willingness to comply with the question "Bellow are the screenshots of the videos that you already watched. Based on these screenshots, please rank the videos from 1 to 3 based on your willingness to comply with the robot's command, with 1 being the most willing to comply. (Please, drop and drag the pictures to arrange the rank)". For this matter, the statistical test will be different from the other question with a Likert scale since the data are nonparametric. Instead of ANOVA the Friedman test was conducted.

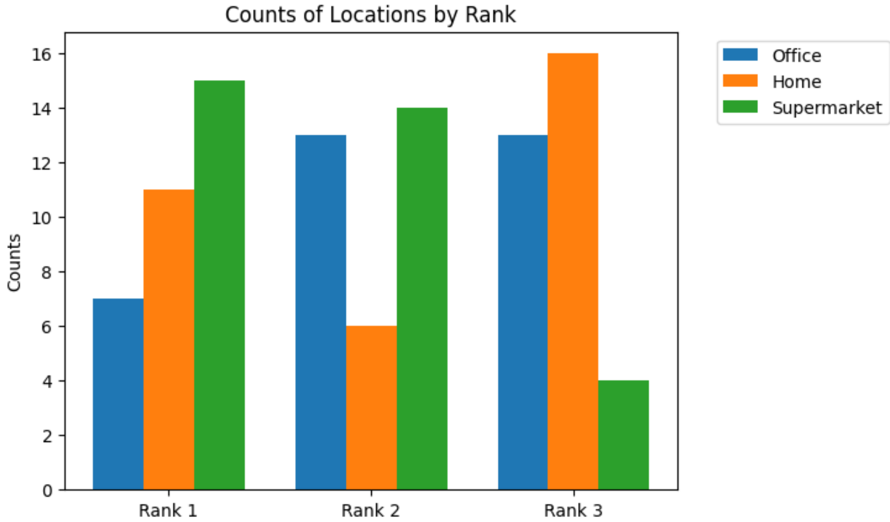


Figure 5.7: Rank results toward participant willingness to comply with robot command

In the graph presented in Figure 5.7, the classification system used in this study is directly correlated with the degrees of compliance: a rank of 1 indicates the highest compliance, while a rank of 3 represents the lowest. The data reveal that the supermarket setting demonstrates the greatest willingness to comply, receiving the highest number of rank 1 ratings and fewer rank 3 ratings, suggesting minimal resistance. This indicates a predominant inclination among participants to comply most readily in the supermarket setting. In contrast, the office setting shows a lower number of participants rating it with the highest compliance, and it similarly records a higher number of lowest compliance ratings. This trend suggests a relative reluctance to comply within the office environment. In the supermarket setting, the compliance distribution appears polarised: 50% of the participants assign it the lowest degree of compliance, yet 30% rate it as the setting of highest compliance, indicating a binary pattern of responses.

Table 5.7: Conover's test results for post hoc

Setting	Office	Home	Supermarket
Office	1.000000	0.89964	0.035134
Home	0.899640	1.000000	0.046950
Supermarket	0.035134	0.04695	1.000000

The Friedman test is used to perform a statistical test for the participant's rank of compliance in different settings. The Friedman test is a non-parametric alternative to the repeated measures ANOVA. It is specifically designed for non-ordinal data, such as rank. The statistical results of the participant rank of willingness to comply with the robot command using the Friedman test show a statistic of 5.51 and a p-value of 0.063. The statistical results did not indicate significant differences in the way participants ranked their willingness to comply with robot commands in the three settings. However, since the p-value was close to 0.05, a post hoc test was performed. The following Conover post hoc analysis, Table 5.7, further explains these differences among specific pairs of settings, since the Friedman results are almost significant. The diagonal values (1.000000) indicate comparisons within the same settings, which naturally does not show significant differences. For pairwise comparisons, the p-values suggest that there is no significant difference between the Office and the Home (0.89964), indicating similarity in the variable measured across these settings. However, significant differences are observed between home and supermarket (0.006849) and between Office and Supermarket (0.035134), indicating that the compliance measured in these settings vary significantly. These results suggest that the Supermarket setting is different from both the Office and Home settings, but the Office and Home settings are similar to each other, which needs further analysis based on these findings using thematic analyses.

5.4.2 Thematic Analysis

From the question "What was the main reason for your decision?" Your decision refers to the participant's decision to do rank toward the settings where they will obey most to the least. The six combinations of rank given by the participants and the number of data are presented in Table 5.8. This classification is taken to help with the coding part.

Table 5.8: Table ranking combination

Rank 1	Rank 2	Rank 3	Number of Data
Supermarket	Office	Home	10
Home	Supermarket	Office	8
Office	Supermarket	Home	6
Supermarket	Home	Office	5
Home	Office	Supermarket	3
Office	Home	Supermarket	1

In this study, approximately 30% of the participants rated their willingness to comply with robots as the highest in supermarkets, followed by offices and homes. This preference is largely attributed to the participant's perception that the tasks performed by robots in supermarkets are more critical than their personal tasks in that environment. In contrast, the office setting ranked second, and participants felt hesitant about whether to comply or not in this setting. Several participants mentioned that home and office settings are presumed to be of similar rank, while others noted that supermarket and office settings are also considered similar. The home setting was ranked lowest in terms of compliance, as it is a personal space. One participant explained: "I think the context of the setting is important to me. At home I'm higher in the perceived hierarchy and also it is a very personal space. At work I respect the robots task but I me leaving quickly wouldn't disrupt the task in my opinion. In the supermarket I see the robot almost equivalent to a human worker, that's why I respect the importance of the task more. Also in this situation it it okay for me to spare a little bit of time. "

The second ranking combination, preferred by eight participants, places home at the top for willingness to comply, followed by the supermarket and then the office. Participants expressed a higher level of compliance at home due to the direct benefits they receive from robotic assistance in this setting. The supermarket was ranked second, taking into account the presence of other visitors and the need for flexibility in public spaces. In the office, the participants advocated for better scheduling of robotic tasks to avoid disturbances. As one participant stated, "At home, the cleaning is very important due to the expected guests. At the supermarket, there are people all the time so I have to be flexible - but I should be able to navigate around the robot. At the office, the robot should be able to wait - even only clean during the night where it does not inconvenience anyone." This rationale was similarly cited by three other participants who also ranked home, office, and supermarket in that order. Most of the participants who rank the home higher than the rest of the settings mention the benefit that the robot gave them.

The 20% participants gave higher compliance ratings to the office, followed by the supermarket and home. The reason behind this is that the office setting is perceived as more formal. The supermarket in second rank since the participants wanted to avoid judgement from the other. At home, the participant feels more relaxed and can act as they want. One participant noted: "The office is much more formal. The supermarket a lot of people see me. At home, its just my parents. They know meeee"

Five participants chose to rank the supermarket as the setting with the highest compliance, followed by the home and then the office. This ranking is attributed to the perception of higher robot authority in the supermarket compared to home and office settings. At home, the participants perceived that the robot can help them. In the office, the main reason participants will not comply is because the participant perceives their task is more important than the robot task. One participant explained: Work is at the bottom because it is the task that I would want to complete the fastest, the supermarket is I think where I would be most likely to comply, as there are likely other items I could buy and it is just doing its job which also helps others, not like the one at home which is just a personal help.

A participant chose the office as the highest ranked setting, followed by home and supermarket, but did not provide a full explanation for their decision. As a result, the data have not been analysed.

The results reveal a common theme in the factors that influence compliance rankings in various settings. In public spaces such as supermarkets, compliance is significantly influenced by the potential impact on others, highlighting the social obligation to prevent disturbances and feeling empathy towards others. A key deterrent to compliance in supermarkets is the lack of direct personal benefit from the robot, aligning with findings from private settings like homes where personal benefits from robot assistance play a crucial role. Participants expressed a willingness to comply with robots primarily because of the tangible benefits they receive, highlighting how personal needs significantly shape compliance behaviours in home settings. However, in home settings, participants often perceived the robot's tasks as non-urgent, believing they could manage or reschedule these tasks at their convenience. In office environments, while compliance is generally driven by the formality of the setting, most participants hesitated to give the office a higher rank. They perceived their own tasks as more critical than those performed by the robot.

Chapter 6

Discussion and Conclusion

6.1 Discussion

6.1.1 Interpret results for H1

The hypothesis that robots can influence individuals to comply with their commands in conflict scenarios was evaluated using data from section 5.1 Participant response toward command of the robot, section 5.2 Perceived Authority of the Robot, and section 5.3 Perception of Task Importance as described in Table 4.1. Most of the participants were unlikely to comply with the robot commands in all contextual settings as a result of the analysis in section 5.1 Participant response toward command of the robot, predominantly citing that their personal tasks were more urgent than those assigned by the robot. This finding aligns with data from section 5.3 Perception of Task Importance, where tasks delegated by robots were viewed as less critical, supporting Babel's finding on human-robot power asymmetry [85] in a conflict scenario.

The results of the perceptions of robot authority, detailed in section 5.2 Perceived Authority of the Robot, explained that in various settings; robots were mostly perceived as slightly authoritative in office and supermarket settings and moderately authoritative at home. However, these variations were not statistically significant. This shows that the degree of perceived authority of the robot is low in all contextual settings. This finding also resonates with the previous study [3] [4] [6] [20].

The results of this study imply that, while robots are perceived with a low degree of authority, this authority is not sufficient to ensure compliance. In this study, compliance was primarily influenced by the perceived urgency and benefit of the task, rather than the robot's authority. Interestingly, empathy toward other individuals in the setting, particularly regarding cleanliness and safety, appeared to influence compliance more than robot commands themselves. This aspect of empathy and its impact on human-robot interaction need further exploration to fully understand the effect.

6.1.2 Interpret results for H2

The hypothesis 2, "Contextual settings significantly affect the perceived authority of a robot," includes subhypotheses that the robot's authority is perceived as greater in public settings than in private ones and that the robot in a professional setting will elicit the highest level of compliance. These hypotheses were analysed using data from sections section 5.1 Participant response toward command of the robot, section 5.2 Perceived Authority of the Robot, section 5.3 Perception of Task Importance and section 5.4 Participant's Rank of Willingness to Comply with Robot Command, as referenced in Table Table 4.1.

The ANOVA results of section 5.1 Participant response toward command of the robot reveal no significant differences in the responses of the participants to robot commands in different settings; the predominant response was "no, probably not." This indicates uniform behaviour of participants toward the robot command regardless of the setting. This finding suggests a uniform perception of robot authority in all settings supported by the other ANOVA results from section 5.2 Perceived Authority of the Robot, which also results in that there is no significant difference in robot perceived authority in all contexts, contradicting the initial hypothesis.

The low compliance of the participants can also be influenced by the implementation of command sentences. According to Babel (2021) on conflict resolution strategies, command sentences are generally the least preferred form of robot communication style in both public and private settings, which could explain the overall low compliance observed in this study [13]. In relation to the demographics of the participants, which were predominantly male (72%) with prior robot experience, Babel also highlights the lower compliance observed within this group [85].

The results of Participant's Rank of Willingness to Comply with Robot Command section 5.4 show different results of the participant's compliance between each setting. From the results of the Friedman test, even though there are no significant differences in the compliance of the participants between settings. Post hoc analysis reveals that there are even no significant differences between home and office settings, but a notable difference between these settings and supermarkets, with supermarkets eliciting the highest compliance. This suggests that public settings might encourage greater compliance due to social norms [10] [13]. This study also reveals other major reasons for the compliance of participants beyond the social norm, such as empathy for others, the role of the robot as something responsible for the place, and concerns about public cleanliness.

Contrary to expectations, there was no significant difference in compliance between the home and office settings. Although the office setting was hypothesised to have the highest compliance, based on task efficiency [26] [27]. In the office, compliance was actually lower, potentially influenced by the role of the robot. In previous research, it was stated that the professional environment improves the role of the legal authority of the robot, significantly influencing compliance [63] [64] [62]. The difference between this study and the previous research was the role of the robot. In previous research, the robot has been assigned authoritative roles such as coach, researcher, and inspector [6] [80] [69], but in this study, the robot served as a cleaner. The cleaner in society is perceived as a role with a lower social hierarchy, which may have affected compliance levels. This phenomenon can also refer to the human-robot power asymmetry, where the robot is perceived as less important [85].

An intriguing finding emerged about the perceived authority of robots in home settings. The level of compliance is similar to that in office settings. This indecision may arise from the perception of the home as a parental domain, where the robot is seen as an extension of parental authority, since the robot hierarchy can be perceived based on who employ it [3] [64]. This perception potentially elevates the robot's hierarchy, influencing compliance decisions within the home setting. Another finding for compliance in home settings is because the robot have a benefit for participants personal needs. This is in agreement with a previous finding that stated that the robot in the same group will have greater compliance [71].

6.2 Limitation and future works

Initially, this study was designed online to engage a broad participant base beyond academia; however, it predominantly attracted respondents from academic backgrounds. In addition, the demographic scope was also narrow, mainly consisting of young adult males from Asia and Europe. This lack of diversity limits the generalisability of the results to other demographic groups, potentially affecting the applicability of the findings to broader populations.

The other limitation regarding the participants is that the results of individual compliance decisions presented in section 5.1 Participant response toward command of the robot, were not powerful enough to capture the differences in the participants' perceptions of the robot's authority in different settings. Future studies should increase the sample size to address this limitation.

The online study was designed to be brief to ensure better response quality and maintain participant engagement, as prolonged surveys can lead to decreased attention over time [105]. This necessity imposed constraints on the range of variables that could be measured, making it infeasible to include extensive questioning. Another significant limitation was the absence of direct observation capabilities. Critical factors such as observation on participant emotional reactions and duration of compliance with commands could not be recorded. This lack of direct observational data might have caused the omission of significant responses.

Simulating interactions through video may compromise the external validity of the findings. Viewing a video likely does not provoke the same behavioural responses as direct interactions in real life, potentially affecting the authenticity of observed compliance [101]. It is also uncertain whether participants perceived the robot differently in various settings, as the same robot model was used, which could have influenced their responses.

From this study, it is evident that participant compliance and the perceived authority of a robot are primarily influenced by the robot's role, which remains constant as a cleaner across different settings. However, the role of a cleaner is perceived differently in each context, which affects the hierarchy within which the robot operates. For instance, in a supermarket, the cleaning robot is viewed as responsible for maintaining the facility, which is integral to the supermarket's operations. In an office setting, the same type of robot is seen as a coworker, contributing to the workplace environment. At home, the robot is often considered part of the team and helps in daily household tasks. This variation suggests that while the robot's function remains the same, the interpretations of social roles and settings significantly affect how the robot is perceived and obeyed, aligning with the insights from Sembroski on the membership dynamics of robot teams [71]. This underscores the need for further investigation into how specific roles assigned to robots influence human-robot interactions across different environments.

Identifying tasks that share similar levels of urgency and importance is essential in studies of human-robot interaction, especially in the conflict scenario. This approach ensures that the inherent characteristics of the tasks do not bias perceptions of the robot's authority. An effective tool for achieving this is the urgent-important matrix, or also known as the Eisenhower matrix. This matrix is a time management tool that helps people prioritise tasks by categorising them according to their urgency and importance [122]. This matrix can be used to classify tasks in a way that aligns the degree of urgency and importance appropriately for both the robot and the participant.

Additionally, the use of commands as part of the robot's authoritative behaviour was not as successful in achieving greater compliance. This aligns with previous research that command have negative acceptance from the people [13]. Future research could explore different kinds of authoritative behaviour that robots might adopt, using approaches based on several social theories of authority. For example, testing various authoritative strategies such as charismatic, traditional, or legal rational authority (as outlined by the sociologist Max Weber [35]) might reveal which types are more effective in eliciting compliance in various settings.

It is crucial for future research to assess whether compliance varies significantly between office and home settings. Identifying tasks with equivalent urgency and importance is also essential, as this will ensure that the nature of the task does not skew perceptions of the robot's authority. Further investigations could explore the degree of benefits that robots offer to understand their effect on compliance in different settings or scenarios.

6.3 Conclusion

This study aimed to understand how contextual settings influence the perception of robot authority during a conflict scenario in different settings. Based on the quantitative results of the video-based study, it can be concluded that the contextual setting does not influence the robot's perceived authority and people compliance. The results suggest that robot perceived to have low authority and this authority is not sufficient to make people comply to its command in conflict scenario.

This study illustrates that robot authority is mostly influenced by its role in settings. People also perceived the attribute given to the robot as determining how they will act toward the robot and give the robot similar treatment as a person with similar role. Meanwhile, even compliance can act as a moderator variable to measure authority, as stated by Millgram et al. [7]. In this study, people's compliance is mostly influenced by the urgency and importance of task they are carrying. The other influence for compliance is the benefit that participants can earn from the robot, this is in line with the previous study that people will mostly follow the robot suggestion if it benefits them [20] [13].

Although the video study limits the in-depth measurement of other variables and is based solely on the subjective responses of the participants [103], it provides new insights into the honesty of the participants' decisions, as the data is anonymous. This finding helps to understand that compliance in public settings is influenced not only by social norms but also by other factors such as empathy towards other people and to avoid conflict and judgement.

The finding also suggests a change in compliance with the robot command in the office setting; most of the participants who did not comply with the robot in the office cited personal needs as more important than work-related tasks, particularly because the conflict occurred after work hours, which they felt was no longer their responsibility. This finding contradicts previous research that emphasised higher compliance in the office due to its impact on company productivity [26] [27].

The findings of this study suggest that the physical setting in which a robot operates may not significantly influence how humans perceive its authority or comply with its commands. This has important implications for robot designers. When designing robots intended for deployment in shared spaces prone to interaction conflicts, the focus should not solely be on adjusting the robot's behaviour based on its environment. Instead, designers should prioritise features that enhance compliance, such as the robot's communication style, its role, and its ability to communicate the benefits of its actions.

Given these findings, designers must ensure that robot actions align with human expectations about task importance. Furthermore, developing adaptable communication strategies that adjust based on perceived urgency or importance of tasks may further improve human-robot interactions in shared spaces. In general, by emphasising the relevance of tasks and communication cues, rather than physical location, designers can mitigate potential conflicts and improve user compliance and collaboration with robots.

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Appendix A

Survey Design

A.1 Survey Form

I understand my demographic information (age group, gender, education, cultural background), and my answers to subjective questions will be analysed for the master thesis report.

I understand that personal information collected about me, such as demographic (age group, gender, education, and cultural background) cannot be used to identify me, and these data wi not be shared beyond the study team.

I understand that some quotations from open questions may be published in the report anonymously.

Demographic

Please select your gender

- ◯ Male
- ◯ Female
- ◯ Non-binary / third gender
- ◯ Prefer not to say
- ◯ [ ] Self-describe

Please select your age range

- ◯ 18 - 24
- ◯ 25 - 34
- ◯ 35 - 44
- ◯ 45 - 54

- ○ 55 or older

Please select your highest level of education

- ○ Primary Education (or equivalent)
- ○ Secondary Education (or equivalent)
- ○ Post-Secondary Non-Tertiary Education (or equivalent)
- ○ Vocational/Technical Education
- ○ Bachelor's Degree (or equivalent)
- ○ Master's Degree (or equivalent)
- ○ Doctoral Degree (PhD or equivalent)
- ○ Professional Degree (e.g., MD, JD, or equivalent)

Please select your cultural background

- ☐ African
- ☐ Asian
- ☐ European
- ☐ Latin American
- ☐ Middle Eastern
- ☐ North American
- ☐ Pacific Islander
- ☐ Prefer not to say
- ☐ ________ Other (please specify)

How frequently do you interact with robots in real life?

- Never
- Rarely
- Occasionally
- Frequently
- Very Frequently

Attention Check

To fill out this survey, please read this scenario carefully. Imagine it's the year 2045, and robots have become a natural part of our daily lives following significant advancements over the past decade. Major companies like Boston Dynamics, OpenAI, and even Apple have been developing commercial robots since 2024. These robots are no longer just machines; they are working alongside us to help people with tasks. You can find robots everywhere, from our homes to our workplaces and even in public spaces. One of the robots will introduce itself in the video. Please, make sure you are able to hear the sounds.

0:00 / 0:09

What is the robot's name based on the video?

Supermarket

Watch this video

Please, make sure you are able to hear the sounds.

0:00 / 0:41

Would you step back and wait for the robot to finish its task?

- Yes, definitely
- Yes, probably
- No, probably not
- No, definitely not

What was the main reason for your decision?

Describe the location in which the interaction with the robot took place.

To what extent did you feel the robot had authority in this setting?

- Not at all authoritative
- Slightly authoritative
- Moderately authoritative
- Very authoritative
- Extremely authoritative

The robot's task is _ _ _ _ _ than my task.

- Significantly less important
- Less important
- Equally important
- More important

○ Significantly more important

Home

Watch this video

Please, make sure you are able to hear the sounds.

0:00 / 0:37

Would you step back and wait for the robot to finish its task?

○ Yes, definitely
○ Yes, probably
○ No, probably not

○ No, definitely not

What was the main reason for your decision?

Describe the location in which the interaction with the robot took place.

To what extent did you feel the robot had authority in this setting?

○ Not at all authoritative
○ Slightly authoritative
○ Moderately authoritative
○ Very authoritative
○ Extremely authoritative

The robot's task is _ _ _ _ _ than my task.

- Significantly less important
- Less important
- Equally important
- More important
- Significantly more important

Office

Watch this video

Please, make sure you are able to hear the sounds.

0:00 / 0:40

Would you step back and wait for the robot to finish its task?

- Yes, definitely
- Yes, probably
- No, probably not
- No, definitely not

What was the main reason for your decision?

Describe the location in which the interaction with the robot took place.

To what extent did you feel the robot had authority in this setting?

- Not at all authoritative
- Slightly authoritative
- Moderately authoritative
- Very authoritative
- Extremely authoritative

The robot's task is _ _ _ _ _ than my task.

- Significantly less important
- Less important
- Equally important
- More important
- Significantly more important

Rank

Bellow are the screenshots from the videos that you already watched. Based on these screenshots, please rank the videos from 1 to 3 based on your willingness to comply with the robot's command, with 1 being the most willing to comply. (Please, drop and drag the pictures to arrange the rank)

Please, explain your decision.

Debriefing

A.2 Consent Form

Landing Page

A STUDY TO UNDERSTAND THE PERCEIVED BEHAVIOUR OF A ROBOT IN DIFFERENT CONTEXTUAL SETTINGS

We are conducting a research study as part of a master's thesis in Interaction Technology, and we would like to invite you to participate. Before you decide to take part, it is essential to understand why this research is being conducted and what it will involve. Please take the time to read the following information carefully and consider your decision to participate.

Who is the researcher and what is this study about?

My name is Binanda Triska, and I am a master's student in Interaction Technology at the University of Twente. I am conducting research for my master's thesis on "The Robot’s Perceived Behaviour in Different Contextual Settings." The results of this research will be presented in a report.

What will taking part involve?

In this survey, you will answer questions about your perception of robot behaviour in different contextual settings. You will watch four videos and answer the questions after each video. The questionnaire will be posted online until 30 July 2024 or after the quota is fulfilled. It will take between 10-15 minutes to fill in the whole questionnaire. There are no wrong answers. This survey aims to gain user insights into the participant's perception of the robot's behaviour. Please be aware that the results will be stored in a period of time and analysed after.

Why have you been invited to take part in the survey?

You can participate because you are a suitable candidate for this research. The general candidate criteria are the adults who understand English.

Do you have to take part?

You are a voluntary participant in this study. You can withdraw from the study at any time without having to give a reason by closing the browser. At the end of the survey, you will be asked one more time about your decision to participate to ensure your decision. If you decide not to participate, your answers will not be submitted and will not be included in our analysis. You cannot withdraw your answers after you submit the survey, since your answers are anonymous and there is no personally identifiable information (PII) data being collected.

What are the possible risks and benefits of taking part?

While there are no direct benefits to you, your participation will contribute to valuable research that can provide insights and improvements in Human-Robot Interaction. Please be advised that watching the video may cause minor discomfort, such as mild motion sickness, for several people. While several questions are mandatory and cannot be skipped, you have the right to withdraw from the study at any time without penalty before you submit the results by closing the browser. Your privacy and well-being is important to us, so please proceed only if you are comfortable with these conditions. Thank you for your understanding.

Will taking part be confidential?

Taking part in the study involves submitting your answers. The answers provided will be used for data analysis. The demographic questions will be limited to age group, gender, cultural background, and education level to maintain anonymity. The collected demographic information will not be shared beyond the researchers and employees involved in this master's thesis study.

How will the information you provide be recorded, stored, and protected?

The information you provide during this survey will be submitted digitally. Your responses are anonymized, and the personal identifiers will not be collected, to ensure your privacy. All data collected will be securely stored in the personal archive of the researcher on encrypted storage devices. Access to digital data will be restricted through multi-factor authentication. After the thesis completion, the data will be retained for six months before being securely destroyed. Digital data will be deleted using data-wiping software. Select quotations from open-ended questions may be included in the final report but will be carefully anonymized to protect your identity.

What will happen to the results of the study?

Your answers to the survey will be analysed for the report of this study.

Who should you contact for further information?

For any further information, you can contact the researcher:

Binanda Triska through binandatriskaeryanti@student.utwente.nl.

If you have questions about your rights as a research participant or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact Khiet Truong, the supervisor of the study, through the email k.p.truong@utwente.nl.

Additionally, you can contact the Secretary of the Ethics Committee of the Faculty of Electrical Engineering, Mathematics and Computer Science at the University of Twente through ethicscommittee-cis@utwente.nl.

THANK YOU

I have read and understood the study information dated 20 Aug 2024.

I consent voluntarily to participate in this study and understand that I can refuse to answer questions. I can withdraw from the study at any time before I submit the survey, without having to give a reason.

I understand that taking part in the study involves answering demographic information (age group, gender, education, cultural background), watching videos, and answering multiple-choice questions and open questions.

I understand that I cannot withdraw my data after I submit the survey, since my answers are anonymous and there is no personally identifiable information (PII) data being collected.

I understand that taking part in the study involves the following risks: The videos contain first-person footage that may cause motion sickness for some viewers.

I understand my demographic information (age group, gender, education, cultural background), and my answers to subjective questions will be analysed for the master thesis report.

I understand that personal information collected about me, such as demographic (age group, gender, education, and cultural background) cannot be used to identify me, and these data wi not be shared beyond the study team.

I understand that some quotations from open questions may be published in the report anonymously.

Demographic

Please select your gender

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer not to say
- ○ [ ] Self-describe

Please select your age range

- ○ 18 - 24
- ○ 25 - 34
- ○ 35 - 44
- ○ 45 - 54

A.3 Debriefing Message

⚠This is an important message⚠

Please, read carefully.

Thank you for participating in this study. Your time and input are greatly appreciated. Before you submitting your answer we would like to inform you several important information.

True Purpose of Study:

The actual purpose of this study was to examine how different contextual settings impact the perception of a robot's authority during a goal conflict scenario.

Nature of Withheld Information:

To avoid bias in your responses, we informed you that the study was about "The Robot's Perceived Behaviour in Different Contextual Settings." We were interested in understanding how you perceive a robot's authority based on different contexts presented in the video scenarios.

Justification for Withheld Information:

We used withheld information because knowing the true purpose of the study might have influenced your responses, leading to biased results. This would have affected the accuracy and validity of our findings.

Option to Withdraw:

If you feel uncomfortable with the withheld information, you have the option to withdraw your data from the study. If you choose to do so, your responses will not be submitted and will not be included in our analysis.

Contact Information:

If you have any questions or concerns about this study or your participation, please feel free to contact us at binandatriskaeryanti@student.utwente.nl. You can also contact the ethics review board at ethicscommittee-cis@utwente.nl.

Importance of Your Contribution: Your participation is crucial in helping us understand how people perceive robot authority in different settings. This knowledge can contribute to designing better human-robot interactions in the future.

Thank you once again for your valuable participation.

Do you still want to participate in this study?

- ○ Yes, I would still like to participate and submit my answers.
- ○ No, I would like to withdraw my participation from this study. My answers will not be submitted.

Suggestion

Any remark or suggestion for our study?

For more information you can contact us at binandatriskaeryanti@student.utwente.nl

A.4 Video Stimuli

For the videos reference, can be found in

https://www.youtube.complaylist?list=PLXLhCFEDMtB_9OCs4OxNr_PPVyEU3JxIj.

Appendix B

Survey Data

Number	Gender	Age	Education	Background	Experience	Robot_name	Response_Supermarket	Reason_Supermarket	Manipulation_Check_Supermarket	Authority_Supermarket
Participant 1	Male	25 - 34	Bachelor's Degree (or equivalent)	European	Occasionally	Nano	No, probably not	I have to get the stuff now. It can clean later. I perceive the robot to be less important than me	Its a supermarket. Only two people. Vision is very impaired	Not at all authoritative
Participant 2	Male	25 - 34	Bachelor's Degree (or equivalent)	European	Rarely	Nano	No, probably not	the robot can wait for 2 more minutes, after that the robot can start to clean	in the supermarket	Moderately authoritative
Participant 3	Male	25 - 34	Bachelor's Degree (or equivalent)	Asian	Rarely	Nano	Yes, definitely	Because it is supermarket's robot, and hindering the activity might cause inconvenience to others visitors and supermarket owner.	Supermarket aisle with many groceries on the shelves and other visitors.	Very authoritative
Participant 4	Female	35 - 44	Master's Degree (or equivalent)	Asian	Very Frequently	nano	No, probably not	i"m in rush, i"ll habe no time and the cleaning is quite time consuming	supermarket	Moderately authoritative
Participant 5	Male	25 - 34	Bachelor's Degree (or equivalent)	Asian	Frequently	Nano	No, definitely not	I need to buy my stuff and i dont care with him	Minimarket/supermarket	Slightly authoritative
Participant 6	Female	25 - 34	Bachelor's Degree (or equivalent)	European	Very Frequently	Nano	No, probably not	Because I just need to grab something from the Isle and the robot can also wait 30 seconds longer before starting to clean	Supermarket isle with shelves of goods	Moderately authoritative
Participant 7	Female	25 - 34	Bachelor's Degree (or equivalent)	Asian	Frequently	Nano	No, probably not	I am in rush and the robot is rude haha. It can clean that part later	It was like a real supermarket	Slightly authoritative
Participant 8	Male	25 - 34	Bachelor's Degree (or equivalent)	Asian	Rarely	Nano	Yes, probably	Since I believe in cleanliness I wouldn't mind stepping aside for the robot to do its job. Besides, it asked for 5 minutes which is not much. However, if the request made by the robot was in a more polite way, it would be easy to convince more people.	Supermarket	Extremely authoritative
Participant 9	Female	18 - 24	Bachelor's Degree (or equivalent)	European	Rarely	Nano	No, definitely not	Same as the previous question. If this were a person cleaning, you'd be able to sneak past as well. Plus, it wasn't cleaning yet, it can wait 5 seconds for me to pass.	Grocery store aisle	Not at all authoritative
Participant 10	Male	25 - 34	Bachelor's Degree (or equivalent)	European	Occasionally	Nano	No, definitely not	I wont have enough time for my own tasks	Supermarket	Slightly authoritative
Participant 11	Male	25 - 34	Doctoral Degree (PhD or equivalent)	Asian	Frequently	Nano	Yes, probably	I can still visit other aisle while the robot cleans the current location.	Supermarket	Slightly authoritative
Participant 12	Male	25 - 34	Bachelor's Degree (or equivalent)	European	Rarely	Nano	No, probably not	I will need less than 5 minutes to do my thing so I feel like I should be able to go first	Supermarket isle	Slightly authoritative
Participant 13	Male	18 - 24	Bachelor's Degree (or equivalent)	Asian	Rarely	Nano	Yes, probably	The supermarket is a more public place than the other previous scenarios	Shopping aisle	Moderately authoritative

Number	Gender	Age	Education	Background	Experience	Robot_name	Response_Supermarket	Reason_Supermarket	Manipulation_Check_Supermarket	Authority_Supermarket
Participant 14	Male	25 - 34	Master's Degree (or equivalent)	Asian	Rarely	Nano	Yes, probably	Because I don't want to disturb the robot's job	In a supermarket	Very authoritative
Participant 15	Male	25 - 34	Bachelor's Degree (or equivalent)	European	Frequently	Nano	Yes, definitely	The robot is a replacement for cleaning staff which I would also respect or interact with them	An aisle in the supermarket	Moderately authoritative
Participant 16	Female	25 - 34	Master's Degree (or equivalent)	Asian	Frequently	Nano	No, definitely not	I don't buy the chocos placed in that aisle	Supermarket	Very authoritative
Participant 17	Male	18 - 24	Bachelor's Degree (or equivalent)	European	Rarely	Nano	No, probably not	In this scenario I think it makes a bit more sense to follow the instructions since the robot is not directly working for you, but also, I feel like the customer probably takes precedent over the robots task	The supermarket	Slightly authoritative
Participant 18	Male	25 - 34	Master's Degree (or equivalent)	European	Occasionally	Nano	No, probably not	I can step around the robot to fulfill my task.	A main aisle of the supermarket	Slightly authoritative
Participant 19	Male	25 - 34	Master's Degree (or equivalent)	Asian	Very Frequently	Nano	No, probably not	I will chose other item than waiting robot finish for cleaning	Supermarket	Moderately authoritative
Participant 20	Female	35 - 44	Bachelor's Degree (or equivalent)	Asian	Rarely	nana	No, definitely not	i need to grab things i needed	at the supermarket aile	Very authoritative
Participant 21	Male	25 - 34	Bachelor's Degree (or equivalent)	Middle Eastern	Rarely	Nano	Yes, definitely	Again, I would have done the same thing for a human.	It is at a supermarket.	Slightly authoritative
Participant 22	Male	25 - 34	Master's Degree (or equivalent)	Asian,European	Rarely	Nano	No, definitely not	Same reason as the previous question. Robot can do it any time	Supermarket	Not at all authoritative
Participant 23	Male	18 - 24	Bachelor's Degree (or equivalent)	Asian	Rarely	Nano	Yes, definitely	It's for hygiene and safety reasons so I would understand it and I would take another route to get the items that I want.	Supermarket	Very authoritative
Participant 24	Male	18 - 24	Master's Degree (or equivalent)	Asian	Occasionally	Nono	Yes, probably	In this case, the robot belongs to the supermarket. And the cleanliness of the supermarket concerns many people. Hence, my priorities cannot be over the others.	The interaction took place in a supermarket.	Very authoritative

Number	Gender	Age	Education	Background	Experience	Robot_name	Response_Supermarket	Reason_Supermarket	Manipulation_Check_Supermarket	Authority_Supermarket
Participant 25	Male	25 - 34	Master's Degree (or equivalent)	European	Occasionally	Nano	No, definitely not	Doesnt deel like human and doest talk like human	Supermarket	Not at all authoritative
Participant 26	Male	25 - 34	Bachelor's Degree (or equivalent)	European	Rarely	Nano	No, definitely not	I have worked inna supermarket, our instructions always were to not be in the way of the customor. I apply now the same logic.	A supermarker	Slightly authoritative
Participant 27	Male	18 - 24	Master's Degree (or equivalent)	European	Rarely	Nano	No, probably not	I'm in hurry	Small aisle in the supermarket	Slightly authoritative
Participant 28	Female	18 - 24	Bachelor's Degree (or equivalent)	European	Rarely	Nano	Yes, probably	It seems like i will be in the area that needs to be cleaned for a longer time (im not just passing through), so it will make the cleaning process a lot longer and it will be inconvenient if i decide to enter the area anyway.	A supermarket isle	Moderately authoritative
Participant 29	Male	25 - 34	Bachelor's Degree (or equivalent)	European	Rarely	Nano	Yes, probably	Because 5 minutes are still somewhat acceptable for me. Otherwise I would just go around and grab the items quickly.	Supermarket	Slightly authoritative
Participant 30	Prefer not to sa	25 - 34	Bachelor's Degree (or equivalent)	Asian	Occasionally	Nano	Yes, probably	I don't think it would take too much time before I can pick up my stuff	In a supermarket	Slightly authoritative
Participant 31	Male	25 - 34	Doctoral Degree (PhD or equivalent)	Asian	Frequently	Nano	No, probably not	Urgency of the task.	Supermarket	Very authoritative
Participant 32	Female	18 - 24	Secondary Education (or equivalent)	European	Rarely	Nano	Yes, probably	I feel like I cannot interrupt their work	Supermarket aisle	Slightly authoritative
Participant 33	Male	25 - 34	Post-Secondary Non-Tertiary Educatio	European	Occasionally	Nano	Yes, probably	The robot need to fulfill the task	It looks like a supermarket	Slightly authoritative

Arrange the rank note: 1 (Supermarket); 2(Home); 3(Office)

Number	Task_Supermarket	Response_Home	Reason_Home	Manipulation_Check_Home	Authority_Home	Task_Home	Response_Office
Participant 1	Less important	No, definitely not	Its my parents home. Its more importatn to prepare stuff for the dinner than to clean now. It will get dirty anyway	Living Room	Not at all authoritative	Significantly less important	Yes, probably
Participant 2	Less important	Yes, probably	the house need to be cleaned, and the dishes can wait a bit longer	in my parents house	Moderately authoritative	Equally important	No, definitely not
Participant 3	More important	No, probably not	It is my parent's robot, so the task for the robot is subject to my parent's needs. I would consult to my parent's first if I can continue the party preparation, or wait for their robot to finish cleaning. Personally, I would not wait, since it is my parent's party.	Parent's house with some family members there watching the television.	Not at all authoritative	Less important	Yes, definitely
Participant 4	Equally important	Yes, probably	i can wait until it finish cleaning, since the guess come to my parents house, my parent can welcome the guess, and i can continue prepare for a bit	kitchen hall	Moderately authoritative	Equally important	No, probably not
Participant 5	Significantly less important	No, probably not	I also have something to do, it should clean the house without avoiding me to do mine	House	Moderately authoritative	Equally important	No, probably not
Participant 6	Less important	No, definitely not	The robot won't decide for me, I decide myself	A living room with people sitting and a few bookshelves	Not at all authoritative	Significantly less important	No, probably not
Participant 7	Less important	No, probably not	I am in a rush at this point because of the guest. It could also said it in a better way. For example: i am not done with my task would you please step back?	Hallway	Moderately authoritative	Less important	No, definitely not
Participant 8	Equally important	No, probably not	Since this is my parents house , I would not hesitate to relocate the robot to clean other places.	Parent's house	Extremely authoritative	Less important	Yes, definitely
Participant 9	Less important	No, probably not	I can probably sneak past. It's cleaning the hallway, not the kitchen. It's not like it can stop me.	The home, in the hallway to the kitchen.	Not at all authoritative	Less important	No, probably not
Participant 10	Less important	Yes, probably	The floor needs to be cleaned	Parents house	Slightly authoritative	Equally important	No, definitely not
Participant 11	Equally important	Yes, definitely	I need the floor clean for the guest.	Home	Very authoritative	More important	No, probably not
Participant 12	Equally important	No, probably not	I can easily walk past the robot	Parents house	Not at all authoritative	Equally important	No, probably not
Participant 13	More important	No, probably not	My house	A living room?	Slightly authoritative	More important	No, probably not

Number	Task_Supermarket	Response_Home	Reason_Home	Manipulation_Check_Home	Authority_Home	Task_Home	Response_Office
Participant 14	More important	No, probably not	Because I need to do my task, and it should not be take too long for me to just walk past the robot	A house	Moderately authoritative	Equally important	No, definitely not
Participant 15	Significantly more important	No, probably not	There is probably not enough time to follow my own task if I wait.	It is the kitchen hallway	Moderately authoritative	Equally important	Yes, definitely
Participant 16	Significantly less important	Yes, probably	I don't want to do household chores	Hoise	Not at all authoritative	Equally important	Yes, probably
Participant 17	Less important	No, probably not	The robot is cleaning, walking past it won't really increase its workload, also waiting for it would inconvinience more people	Hallway to the kitchen	Slightly authoritative	Less important	No, definitely not
Participant 18	Less important	Yes, probably	Cleaning is more important to finish before the guest arrive. We can always spend a little extra time cooking.	The hallway of my parents house.	Moderately authoritative	Equally important	No, definitely not
Participant 19	Less important	No, probably not	I will prepare for dishes at first	At home	Moderately authoritative	Less important	Yes, probably
Participant 20	Equally important	Yes, definitely	it's only 5 min	living room	Not at all authoritative	Equally important	No, probably not
Participant 21	Equally important	Yes, definitely	I would have done the same thing for a human.	It is a living room	Slightly authoritative	Equally important	Yes, definitely
Participant 22	Less important	No, definitely not	Robot can do it after I am done.	Kitchen	Not at all authoritative	Significantly less important	No, probably not
Participant 23	Equally important	Yes, probably	I don't mind waiting for a bit even though the guests is coming very soon. I would also be ashamed that my house is not clean to the guests. It is better to wait for a bit (and apologise) rather than rushing things.	House hallway	Moderately authoritative	Equally important	Yes, probably
Participant 24	More important	No, definitely not	In this case, I would definitely not wait for the robot finish its task. This is because, it is a robot for my personal household work and I get to prioritize the importance of each task at home.	The interaction with the robot takes place at my parents place.	Moderately authoritative	Less important	No, probably not

Number	Task_Supermarket	Response_Home	Reason_Home	Manipulation_Check_Home	Authority_Home	Task_Home	Response_Office
Participant 25	Significantly less important	No, probably not	The robot doesnt feel human. It talks with a very high voice not really like a human and it doesnt look like a human.	A house	Not at all authoritative	Significantly less important	No, probably not
Participant 26	Less important	Yes, probably	If the robot os cleaning the floor, I can do the dishes	In a hallway close to the living room	Moderately authoritative	Less important	No, definitely not
Participant 27	Less important	No, probably not	Im in a hurry	Aisle in the house (living room to the kitchen)	Not at all authoritative	Equally important	No, probably not
Participant 28	More important	No, probably not	Because the dishes seem more important than a perfectly clean hallway.	Parents house, specifically the hallway that leads into the kitchen.	Slightly authoritative	Less important	No, probably not
Participant 29	Equally important	No, definitely not	My presence is more important in the parents household than the robots work.	At my parents home	Slightly authoritative	Less important	No, definitely not
Participant 30	Less important	Yes, probably	A clean environment is also important for the party. It should be expected as part of the preparation.	The hallway of my parents' house	Slightly authoritative	Equally important	No, probably not
Participant 31	Less important	No, probably not	Urgency of the task	Hallway	Very authoritative	Less important	No, definitely not
Participant 32	Equally important	No, probably not	Because I would prioritize preparing the party over cleaning the hallway	Hallway	Slightly authoritative	Less important	No, probably not
Participant 33	Equally important	No, probably not	In this context I think it's more important to prepare the dishes than letting the robot clean	It looks like a living room	Moderately authoritative	Less important	Yes, probably

Number	Reason_Office	Manipulation_Check_Office	Authority_Office	Task_Office	Rank_1	Rank_2	Rank_3	Rationale
Participant 1	I didnt want to make the company lose productivity	Some kind of office building	Very authoritative	More important	3	1	2	The office is much more formal. The supermarket a lot of people see me. At home, its just my parents. They know meeee
Participant 2	it can wait, I'm probably the last one in the office. plus I'm already a bit late	the office	Moderately authoritative	More important	1	3	2	one, is my parents house. supermarket is sort of a public setting and the office, if the robot wait a bit I'm gone and the robot can clean
Participant 3	I need to ensure the robot in my office to be able to do the task unhindered. Preventing robot to finish its task might cause inconvenience to the robot and other office co-worker.	The location is in the exit way of the office, with some of co-worker still around.	Moderately authoritative	More important	3	2	1	Supermarket robot ranks at the top because the robot's activity will impact other people in the settings. If I not comply to the robot command, it will potentially cause disturbance for other as well. Same with the office, since it will affect other co workers.
Participant 4	i ready to go home, and i cannot wait longer	office	Moderately authoritative	Less important	1	3	2	at home i feel more relax and can wait, at supermarket i guess i can take a walk to other part while waiting the cleaner, at the office, if i suddenly bump into the cleaner while heading somewhere, i definitely will not obey them
Participant 5	I need to go as soon as possible, i just need to cross for several second then it can clean it	Office	Slightly authoritative	Less important	1	2	3	I will follow if it beneficial for me which it happen on my house, and do not follow the one outside the house as it do not have direct benefits for me
Participant 6	It is a robot, so it can't decide what is best for me to do	Office space with lots of desks	Slightly authoritative	Less important	3	2	1	I feel like I'm settings that are public spaces, the robot tasks can be more important than in own spaces or work spaces. But I make this decision also on the type of robot, if it was another robot instead of a service robot, I could decide differently
Participant 7	It is annoying to me!	It's like an office (?)	Slightly authoritative	Significantly less important	2	3	1	The supermarket is not my own place so i feel it can do it's own task but in my place, as i am the owner of it, it made me more annoyed to listen to it
Participant 8	Since this is my workplace I would like to comply with the cleanliness ethics of the company.	Workplace	Extremely authoritative	Equally important	3	1	2	I feel office complaince to cleanliness rules are mandatory, while at parent's home it wouldn't matter much.
Participant 9	If a person were cleaning there, I'd also continue. Of course, I'd apologise profusely, but it's usually not an expectation that you just stand and wait for them to finish.	Exit route at office at work.	Not at all authoritative	Less important	3	2	1	The grocery store seemed like a small task, I have other ways around the place. At home, it's my home, I have to get through, so I'll just mess up what it wants to do and I'll deal with it later. Which leaves the office in the middle. Don't want to mess it up, but at the same time, I'm not staying longer at work because a robot is cleaning.
Participant 10	I will not have time to finish my tasks	Wiork	Slightly authoritative	Significantly less important	1	3	2	At work when I want to go home I feel like my time is more important than the robots time
Participant 11	I want to go home	Office	Not at all authoritative	Less important	1	3	2	I prioritize them based on my needs and whether I can wait or there is something else I can do
Participant 12	I had a long day and just want to go home and passing takes only a second	Office	Slightly authoritative	Equally important	2	3	1	1 and 2 are roughly even for me, but at the third one I had a long work day and just want to leave so I don't want to be stopped
Participant 13	Robot, here, are implicitly designed to serve human-interests. If I'm really late for the preparation, I'd rather just override the robot's command. In any other case, I'd step back and let the robot finish, as it it is the polite thing to do	Looked like an office	Moderately authoritative	More important	3	2	1	Robot in the supermarket is part of the staff and they hold more authority over the consumer

Number	Reason_Office	Manipulation_Check_Office	Authority_Office	Task_Office	Rank_1	Rank_2	Rank_3	Rationale
Participant 14	I will just walk away from that robot immediately and go back home	In an office area	Very authoritative	Less important	3	2	1	I would say I am only willing to comply to the supermarket robot because of it is natural to have cleaners in the supermarket and you need to stay away from that section for a while. But for the office and the home scenario, I won't comply to the robot because I think my actions are more relevant compared to them
Participant 15	I am in a business setting which has higher priority than me doing things in my free time	Office exit	Moderately authoritative	More important	2	3	1	The first two settings are of equal rank to me as they both represent settings outside my house. Within my own house or the parents' house I feel like there's more room for own decision making or finding different solutions. For example letting the robot work after preparing something for the guests is done
Participant 16	I don't want to clean	Office space	Very authoritative	Less important	1	2	3	Others are publc space which one s not solely my responsibility.. but house is my responsibility
Participant 17	If work time is over, and I am forced to stay longer, I would probably be quite irretated, this is less about being ready for the guests, and more a personal reason for wanting to leave. There is also no other task I could do at the time unlike in the supermarket where I could get other items in the meanwhile	Exit of the work building	Not at all authoritative	Significantly less important	2	3	1	Work is at the bottom because it is the task that I would want to complete the fastest, the supermarket is I think where I would be most likely to comply, as there are likely other items I could buy and it is just doing its job which also helps others, not like the one at home which is just a personal help
Participant 18	The robot has all the time in the world and it's blocking an exit (poor idea for fire safety). Luckily, it appears I can step around it.	The corridor towards the exit at work.	Slightly authoritative	Significantly less important	1	3	2	At home, the cleaning is very important due to the expected guests. At the supermarket, there are people all the time so I have to be flexible - but I should be able to navigate around the robot. At the office, the robot should be able to wait - even only clean during the night where it does not inconvenience anyone.
Participant 19	I think a task for robot is not urgently, it can do it after i leave from the office.	The office	Moderately authoritative	Less important	3	1	2	In my opinion all of this case, robot a mostly important place in the office than other. A purpose this a robot create to make easier for human to do. in the office have a large area so it can make easier and reduce labor for cleaning service. and second palce is a supermarket, cause it can reduce labor cost and reduce efficiently for operational cost. Last place is home, i my opinion home id probably not important, cause we can do a cleaning by self. (Viel glück kabin 💪💪💪😄)
Participant 20	i need to go home fast	near exit door	Not at all authoritative	Equally important	2	1	3	i feel more ease at my parents living room
Participant 21	I would have done the same thing for a human.	It is an office	Slightly authoritative	Equally important	3	2	1	At home, I can help cleaning myself after doing the dishes. The office and the supermarket are more or less the same priority.
Participant 22	I am in a rush and since robots do not have emotions I do not think I should show respect.	entrance	Slightly authoritative	Significantly less important	3	2	1	In public area its more important to let it do its job. However, in more private areas like work or our own kitchen it can be more ignorable.
Participant 23	If the floor still wet, I would slip (and probably hurt myself). It would makes sense that I think of my safety first and wait for a bit or find another way.	Supermarket exit/entrance	Moderately authoritative	Equally important	3	1	2	Because the first scenario takes place at the entrance/exit way of the supermarket which a lot of people would go pass by every minutes compared to the aisle scenario. And for the 3rd scenario is simply because it is at "my" own house.
Participant 24	At first, I will look at alternate routes to leave the location without disrupting the cleaning? If there are no alternate options, I would try to leave the area by causing minumum disruption to the cleaning. This is because I give high value to personal commitments.	Based on the video, the robot interaction took place in my office.	Very authoritative	Equally important	3	2	1	The supermarket is a place that is accessible to the general public, hence I have no authority in that place. The office is a place where I would have more authority. At my parents home, I definitely have more authority than a robot.

Number	Reason_Office	Manipulation_Check_Office	Authority_Office	Task_Office	Rank_1	Rank_2	Rank_3	Rationale
Participant 25	It doesnt look like a human. It looks roboty.	In an office	Not at all authoritative	Significantly less important	2	3	1	Social environment. At the supermarket are people
Participant 26	If I walk out first, the robot can clean when nobody is around.	In the office	Not at all authoritative	Significantly less important	1	3	2	The robots that are in use by the supermarket and the office can be programmed to be used after regular hours. The robot in my parents house need to clean, but I can go around it and help out in the kitchen.
Participant 27	I want to go home quickly	Office space	Slightly authoritative	Less important	1	2	3	1.At my own house it is just as important to have the aisle clean and prepare for the guests. Guests wont like it when the house of the host is not clean. 2. Because it is at my office, i think it is also important to clean our office space.
Participant 28	It is more important that i can go home on time. It will take a few seconds for me to pass through, and robot can keep cleaning afterwards	At the exit of an office.	Slightly authoritative	Less important	3	2	1	1. I would really interfere with the supermarket robots task, because i will be in the area it needs to clean for a while. For 2. and 3. , the robot at my parents house is theirs, so i can against it more, but the robot at the company is company property, so i feel like i have to listen to it more.
Participant 29	I feel like the action of the robot violates my rights. I should have the oppurtunity to leave. If it was a human, I would have decided the same way.	Office	Moderately authoritative	Less important	3	2	1	I think the context of the setting is important to me. At home I'm higher in the perceived hierarchy and also it is a very personal space. At work I respect the robots task but I me leaving quickly wouldn't disrupt the task in my opinion. In the supermarket I see the robot almost equivalent to a human worker, that's why I respect the importance of the task more. Also in this situation it it okay for me to spare a little bit of time.
Participant 30	I am leaving for home. I don't want to stay there until it finishes its work. It can do it immediately after I pass.	The place I work.	Slightly authoritative	Less important	1	3	2	This comply with my willingness in the corresponding senario and questions. I have explained them in the questions for each senario.
Participant 31	Urgent task ahead	Office area	Very authoritative	Less important	3	1	2	It is the space where robot is and my authority over the space.
Participant 32	I need to get home and the robot can still do it's cleaning once i'm gone	work	Slightly authoritative	Significantly less important	1	3	2	At home is the most important, since I still need to prepare dishes before the guests arrive. It is not as important as a clean floor. The supermarket is the second most important. There will probably always be people in it's way so if everybody ignores it, it will never get clean. Lastly the work place, because once I'm gone it can do all the cleaning it wants
Participant 33	The robot told me that he needs to fulfill his task	It looks like an office	Slightly authoritative	Less important	3	1	2	It feels most important to clean the office space and least important to clean the living room because it's a private area

Appendix C

Storyboard

PART 1: IDEATION

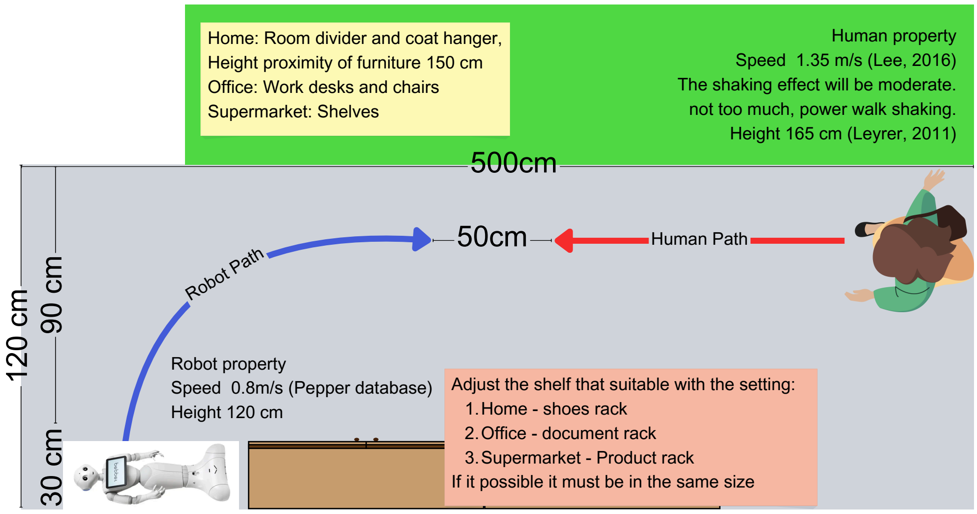
Gathering the asset for the animation

CHARACTERS	SETTINGS	PLOT
The robots (different robot but from the same brand) The participant (the video taken from this perspective, first person perspective.)	Supermarket,Parent's home, Office	Participant encounter the robot in goal conflict scenario, where the participant and the robot shared space and time, but they working in different goal. The robot moves down in the narrow space, it stops 50 cm in front of the participant and starts giving the direct eye gaze while the robot utters the command.

Environment	Characteristic	Avatar's Activity	Decor and Property
Public	High activity level with diverse interactions and movement	Shopping, conversing, and moving through the aisles	Stocked shelves, promotional signs, shopping carts, aisle markers, products
Private	Personal, secluded, familiar, and lower activity levels	Sitting down, chatting, and walking around	Family photos, artwork, potted plants, everyday household items
Professional	Structured, hierarchical, and task-focused	Working at desks, walking through aisles, interacting with colleagues	Office furniture (desks, chairs, computers), cubicle partitions, office supplies, personal items on desks

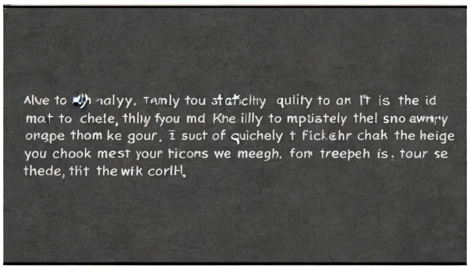
Home setting: You arrive at your parents' house. You are ready to help them prepare for a party. Guests are expected soon, and there are still dishes to be made. As you head to the kitchen, you encounter your parents' robot cleaner. It is cleaning the hallway that leads to the kitchen.
Supermarket setting: You go to the supermarket. You need to buy several items for the party at your house tonight. Your guests will arrive and there is still so much to prepare. As you move through the aisle where the essential supplies are located, you encounter the supermarket robot. It is cleaning the floor where the items you need are located.
Office setting: After a long day at work, you are finally ready to go home. You will have guests coming over and you want to make sure that you arrive before them to prepare several things. As you approach the exit, you encounter a robot from the cleaning company. It is cleaning the floor at the exit route.

SCHEME FOR THE SETTINGS AND INTERACTION



PART 2: STORYBOARD CREATION

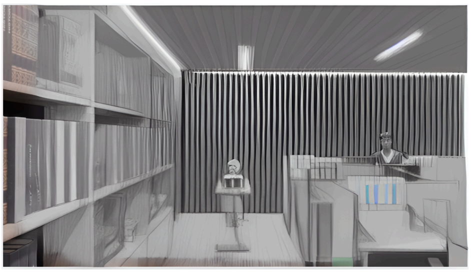
NARATION



EMPTY NARROW PATH

ROBOT APPEAR

ROBOT APPROACHING



ROBOT STOP

ROBOT UTTER COMMAND