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**Deploying Social Robots for Multilingual Accessibility:  
Supporting Newcomers and Staff in Public Service Spaces**

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Submitted in fulfilment of the requirements for the  
Degree of Doctor of Philosophy

School of Computing Science  
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University  
of Glasgow

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# Abstract

Millions of people around the world migrate each year for myriad reasons. Some move to find better job opportunities, others pursue education abroad, and many are forced to leave their countries due to conflict or persecution, such as refugees and asylum seekers. These newly arrived individuals face many challenges, such as navigating bureaucracy and accessing services. Language barriers can heighten stress during these interactions, especially when newcomers are not fluent in the host country's language. In many cases, when support is offered in the host country, it is provided in the formal language of that country. Yet, studies on second-language interaction and access to services show that clients often prefer to use their native language. Communicating in their first language helps them express emotions, explain problems, and reflect on situations more effectively. Common workarounds include scheduling appointments with a translator, asking a friend to interpret, or relying on tools like Google Translate and hoping for accurate results. Multilingual social robots can be instrumental in providing support. However, care must be taken when developing any speech-based system, as it is crucial to take into account the linguistic needs of its target population. It is paramount not to perpetuate existing biases from the language and speech technology communities. To address these gaps, I have developed a multilingual support robot designed to work alongside human support workers who assist newcomers. The robot was deployed in public spaces, interacting with users in their native languages across two settings: 1) a student services center, and 2) a drop-in service for refugees and asylum seekers. Each design and deployment process was guided by consultations with key stakeholders to ensure contextual relevance. This work presents two tailored applications of the robot, each evaluated using complementary methods. First, I describe its use with international students at the University of Glasgow, assessed through a controlled lab study and an in-the-wild deployment. Second, I present its adaptation for refugees and asylum seekers at a charity drop-in service, informed by a co-design process with Syrian refugees and later evaluated through an in-the-wild study. Through these real-world applications, the thesis demonstrates the potential of multilingual support robots and provides practical guidelines for their deployment in public service environments.

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# Abbreviations

<b>ABOT</b>	Anthropomorphic roBOT
<b>ASR</b>	Automatic Speech Recognition
<b>CA</b>	Conversational Agent
<b>DM</b>	Dialogue Manager
<b>ECA</b>	Embodied Conversational Agent
<b>ESOL</b>	English for Speakers of Other Languages
<b>HCI</b>	Human-Computer Interaction
<b>HRI</b>	Human-Robot Interaction
<b>L1</b>	First Language
<b>L2</b>	Second Language
<b>LLM</b>	Large Language Model
<b>NGO</b>	Non-Government Organization
<b>NLG</b>	Natural Language Generation
<b>NLU</b>	Natural Language Understanding
<b>PD</b>	Participatory Design
<b>RAG</b>	Retrieval-Augmented Generation
<b>RALL</b>	Robot-Assisted Language Learning
<b>RAS</b>	Refugees and Asylum Seekers
<b>TTS</b>	Text To Speech
<b>WEIRD</b>	Western, Educated, Industrialized, Rich, and Democratic

# Ethics

Ethical approval for the studies presented in this thesis was granted by the University of Glasgow College of Science and Engineering Ethics Committee and resulting data was processed in line with legal requirements. The associated ethics application reference numbers for these studies are:

1. **Student Lab Study (Chapter 4):** #300230104,
2. **Student In-The-Wild Study (Chapter 4):** #300230012, #300230112
3. **Refugee Co-Design Study (Chapter 5):** #300230106, #300230167
4. **Refugee In-The-Wild Study (Chapter 5):** #300240102, #300240128

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# Declaration and Contributing Publications

I declare that, except where explicit reference is made to the contribution of others, that this thesis is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

The following publications are based on work presented in this thesis:

- **All Studies (Chapters 4 & 5):**

Ashkenazi, S., Skantze, G., Stuart-Smith, J., and Foster, M. E. (2024). Goes to the Heart: Speaking the User’s Native Language. *Companion of the 2024 ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, pp. 214-218.

DOI: 10.1145/3610978.3640633

Foster, M. E., Ashkenazi, S., Blair, A., Ramirez-Duque, A., Ali, S., Candelaria, P., & Zeller, F. (2024). Including Front-Line Workers as Primary Stakeholders in Public-Space HRI. *First International Workshop on Worker Robot Relationships @ HRI’24*.

- **Student Lab Study (Chapter 4):** Ashkenazi, S., Skantze, G., Stuart-Smith, J., and Foster, M.E. (2025). The Multilingual Student Support Robot. *2025 34th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*, pp. 953-958. DOI: 10.1109/RO-MAN63969.2025.11217768

- **Refugee Co-Design Study (Chapter 5):** Ashkenazi, S., Srouf-Zreik, R., Skantze, G., Stuart-Smith, J., and Foster, M.E. (2026). Participatory Design for Human-Robot Interaction with Syrian Refugees and Asylum Seekers. *2025 International Conference on Social Robotics + AI (ICSR+AI)*, pp. 92-105. DOI: 10.1007/978-981-95-2382-5\_7

- **Guidelines (Chapter 6):** Ashkenazi, S., Skantze, G., Stuart-Smith, J., and Foster, M.E. (2025). Into the Wild: When Robots Are Not Welcome. *Real-World HRI in Public and Private Spaces: Successes, Failures and Lessons Learned (PubRob-Fails) @ RO-MAN’25*. DOI: 10.48550/arXiv.2508.12075

**Shaul Ashkenazi**

# Chapter 1

## Introduction

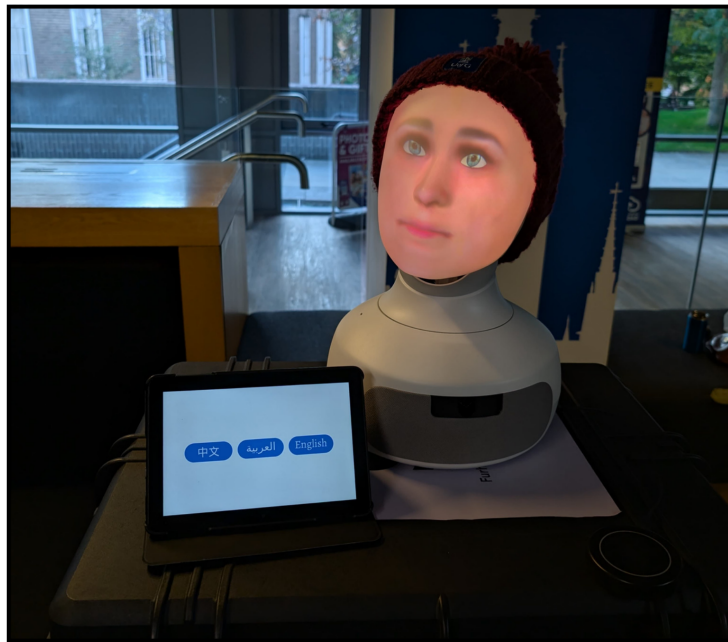


Figure 1.1: The robot system

### 1.1 Motivation

Global migration is driven by a mix of *push* factors, such as conflict and political instability, and *pull* factors, such as access to education and better opportunities [3]. This thesis focuses on two groups shaped by these dynamics: international students, drawn by higher education, and refugees and asylum seekers, displaced by conflict. Throughout this thesis, these groups are collectively referred to as newcomers, reflecting their shared experience of recently arriving in a host country and navigating unfamiliar institutional and social environments.

Social robots are increasingly deployed in public spaces [4, 5], with recent studies reporting robots acting as a receptionist [6], a museum guide [7], and a barista [8], among other roles.

As robots become more prevalent, they are likely to play a growing role in mediating access to public services and information. However, existing studies rarely consider the experiences of newcomers, whose needs may differ substantially from those of established users. Addressing newcomer needs at this stage is therefore critical to ensure that future robot-mediated public spaces are inclusive rather than exclusionary.

Prior work highlights several contexts in which the physical embodiment of robots plays an important role compared to voice-based assistants. In a widely cited vignette-based experimental study, participants evaluating a restaurant waiter robot indicated that human-like design characteristics play a critical role in shaping responses [9]. Furthermore, Frontline robots can make customers perceive the interaction as taking place with another social actor [10], and in a study comparing interactions with a robot and a tablet computer delivering healthcare instructions, participants reported a stronger sense of connection with the robot [11].

Building on this literature, embodiment may also influence how customers evaluate the service provider itself. Prior research demonstrates that customers rely on observable cues to infer service quality [12, 13]. In this regard, the use of advanced technology (e.g., social robots) in contrast to less sophisticated technologies (e.g., a touch-screen tablet), can function as a salient and visible signal of organizational competence and investment, leading users to infer higher service quality [14, 15].

Language barriers often complicate access to essential services for these groups. Social robots, embodied conversational agents capable of verbal and non-verbal interaction, offer a promising solution. Prior research emphasizes that effective communication matters more than appearance for successful human-robot interaction [16]. Multilingual capabilities, therefore, are critical for usability and inclusivity. Among widely studied social robots, the Furhat robot [17] stands out for its strong conversational focus and expressive facial capabilities, enabling nuanced non-verbal cues. Compared to other humanoid social robots, which have bodies but limited facial expressiveness, Furhat offers richer emotional expressiveness and is perceived as more intelligent and trustworthy [18]. These qualities make it particularly suitable for multilingual support tasks, where interaction in a user’s native language is central, and expressive facial cues can complement verbal communication by providing additional social context.

While social robots have been deployed in public spaces for tasks such as information provision and education [19], most studies occur in controlled environments. Researchers increasingly advocate for real-world evaluations to capture authentic interactions and challenges [20, 4]. However, in-the-wild deployments remain rare and present technical and social hurdles, including user unfamiliarity and site permissions [21, 22].

This thesis explores how a multilingual social robot can support newcomers in public service contexts. We deployed a Furhat robot (Fig. 1.1) in two real-world settings: (1) a student services center and (2) a drop-in service for refugees and asylum seekers (RAS) (Fig. 1.2). As RAS are a vulnerable population, the researcher engaged in *observant participation* by volunteering

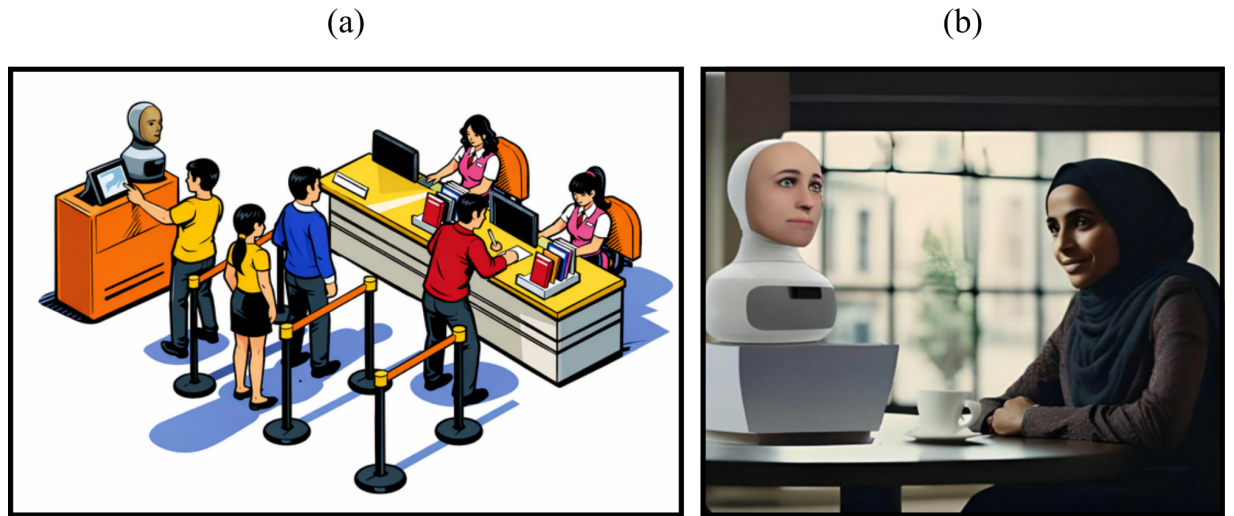


Figure 1.2: Furhat deployed in (a) a student services center and (b) a refugee drop-in service

in an organization supporting them, while also observing university support staff supporting international students, in order to ground the robot deployments in real-world practices and interactions. Each deployment was informed by stakeholder consultations to ensure contextual relevance.

## 1.2 Thesis Statement

Non-native English speakers seeking support are more likely to prefer robots that speak their native language over English-only human providers. Human-Robot Interaction (HRI) in a native language enhances users' overall communication efficacy, reduces cognitive demand, and increases their willingness to engage with the robot, perceiving it as useful, pleasant, and friendly.

## 1.3 Thesis Research Questions

This thesis addresses the following research questions through a mixed-methods approach, including interviews, surveys, and user studies:

**RQ1** Which services do newcomers need, and how do they currently access them?

**RQ2** To what extent are human support services willing to integrate social robots into their offerings?

**RQ3** Do newcomers prefer accessing services in their native language, even when provided by a robot?

## 1.4 Contributions

This thesis makes several contributions to HRI research and practice:

### 1.4.1 Advancing Multilingual HRI in Bureaucratic Support Contexts

This work addresses a gap in HRI research by focusing on bureaucratic support for newcomers, a context where language barriers and procedural complexity are particularly challenging. The student support robot described in the Student Lab & In-The-Wild studies was co-designed with Student Services staff and deployed during peak demand periods at the University of Glasgow. Its design combined multilingual assistance with a visible sign of institutional support, fostering inclusion and belonging while empowering staff to focus on complex cases.

### 1.4.2 First Social Robot Co-Design with RAS

The Refugee Co-Design Study represents the first co-design process of a social robot aimed at addressing bureaucratic needs of RAS. Through qualitative thematic analysis, we confirmed that participants face challenges similar to those reported in prior research and expressed enthusiasm for robots as a complement to existing support systems.

### 1.4.3 Deployment of a Bilingual Support Robot for RAS

The Refugee In-The-Wild Study introduced the first bilingual social robot designed for bureaucratic support of RAS, based on insights from co-design sessions and stakeholder meetings. Like the student support deployment, this robot was placed in real-world service environments (e.g., the CWIN drop-in center), demonstrating feasibility and acceptability in community settings.

### 1.4.4 Guidelines for Deploying Robots in Public Service Spaces

Chapter 6 synthesizes lessons learned from these deployments and proposes a definition of a “*public service space*” for HRI research: *a publicly accessible environment where people can freely assemble, move about, and interact while accessing services of general interest that are defined, overseen, or guaranteed by public authorities, even when those services are delivered by private or third-sector providers.*

The chapter emphasizes that technical capability alone is insufficient for successful deployment. Organizational scale, structure, and stakeholder engagement critically shape outcomes. Future deployments should prioritize inclusivity, transparency, and long-term community benefit, while advancing technologies for under-resourced languages to support users who need this technology rather than merely prefer it.

### 1.4.5 Novel Application of Stakeholder Analysis Framework

While prior HRI studies have examined stakeholder perspectives (e.g., [23]) and referenced Newcombe’s stakeholder framework, only Höpfl et al. [1] applied Newcombe’s stakeholder mapping [2]. Their work focused on interviewees from diverse backgrounds recruited through purposive sampling, without limiting participation to a single facility.

To the researcher’s knowledge, this thesis is the first to apply Newcombe’s framework for a comprehensive stakeholder analysis in the deployment of a social robot within public service spaces. This approach enabled a systematic examination of organizational dynamics and acceptance factors, extending the framework’s use beyond its previous application in elderly care settings.

## 1.5 Thesis Structure

This thesis is organized into seven chapters. The current chapter introduces the research context, outlines the motivation, and presents the research questions guiding this work.

**Chapter 2** situates the work of this thesis within relevant literature. It begins by examining language-related challenges faced by newcomers, then reviews prior technological solutions for multilingual accessibility. Next, it considers social robots as supportive embodied agents and concludes by discussing the challenges of deploying social robots in real-world setting.

**Chapter 3** details the methodological approach used in this thesis. It begins with a description of the multilingual robotic system and its interaction design, followed by an overview of the language processing pipeline and system architecture. The chapter then outlines the data collection methods and presents the overall research approach, combining mixed-methods, participatory elements, and real-world deployment. It concludes with an ethnographic reflection on the researcher’s role and positionality in working with diverse and hard-to-reach populations.

**Chapter 4** explores how social robots can assist international students in navigating university support services during their initial weeks in the UK. While previous work has examined multilingual interfaces in educational contexts, newly arrived students often face unique challenges, including language shock and bureaucratic complexity. To address these issues, we present the design and evaluation of a multilingual support robot that communicates in English, Mandarin Chinese, and Modern Standard Arabic. Through two complementary studies: (1) a controlled lab experiment and (2) an in-the-wild deployment, we investigate user needs, language preferences, and real-world performance in authentic university settings.

**Chapter 5** examines how social robots can support refugees and asylum seekers (RAS) in accessing essential services during resettlement. Building on the previous chapter’s focus on multilingual support for international students, we now turn to displaced populations, who face additional challenges such as heightened vulnerability and complex integration needs. To address these issues, we present the design and deployment of a bilingual robot that communicates in Modern Standard Arabic and English, developed in collaboration with local stakeholders. Through two complementary studies: (1) a participatory design process and (2) an in-the-wild deployment, we investigate user needs, attitudes, and real-world performance within a drop-in service context.

**Chapter 6** synthesizes lessons learned from the deployment of social robots in public service spaces, including a student services center and a RAS drop-in service. Building on these insights, the chapter develops a set of practical guidelines for future deployments, addressing both organizational dynamics and user-centered design considerations.

**Chapter 7** concludes the thesis by first summarizing the main findings in relation to the research questions. It then identifies a set of cross-cutting insights that highlight broader implications for Human-Robot Interaction in public service contexts. The chapter further articulates the thesis contributions, discusses limitations and future research directions, and concludes with reflections on the role of social robots in supporting inclusive access to services.

# Chapter 2

## Literature Review

This chapter situates the work of this thesis within relevant literature. It begins by examining language-related challenges faced by newcomers, then reviews prior technological solutions for multilingual accessibility. Next, it considers social robots as supportive embodied agents and concludes by discussing the challenges of deploying social robots in real-world settings.

### 2.1 Linguistic, Social and Structural Barriers for Newcomers

Millions of people move across borders each year for myriad reasons, commonly categorized as *push* factors (negative) and *pull* factors (positive) [3]. Push factors include climate change-related drought and famine [24], escaping conflict zones [25], and government distrust [26], while pull factors include access to quality higher education [27], better job opportunities [28], and family reunification and community ties [29]. This thesis focuses on two groups shaped by these dynamics: (1) international students, driven by the pull factor of higher education, and (2) refugees and asylum seekers, driven by the push factor of escaping conflict.

Newcomers face multiple, interrelated barriers when accessing services, which can be broadly categorized into (1) linguistic barriers, (2) social and psychological barriers, and (3) structural and logistical barriers.

#### 2.1.1 Linguistic Barriers

Foreign Language Anxiety (FLA) is described as “*the worry and negative emotional reaction aroused when learning or using a second language*” [30]. It captures the emotional dimension of learning and using a second language and is closely related to test anxiety [31]. FLA has been widely studied, and interventions to reduce it include online games [32], mindfulness-based practices [33], and music listening [34].

Beyond FLA, learning and interacting in a new language remains a broader source of stress and a barrier to integration. For second language (L2) learners post-puberty, this process in-

volves not only mastering syntax and phonology but also socialization, which means learning local customs and becoming part of a new speaking community [35]. Multilinguals often prefer their first language (L1) for emotional communication, mental calculations, and inner speech, as it is typically more emotionally resonant. However, longer immersion can gradually shift these preferences [36]. These dynamics become especially relevant in bilingual service interactions, where the “service seeker” and “service provider” adjust their language choices and interaction style to manage power, politeness, and identity. The service seeker may shift between social and linguistic identities to ease tension or avoid conflict. Personalization should therefore account for the seeker’s preferred language, particularly in ongoing interactions rather than one-off encounters [37].

Because access to services typically occurs in the host country’s majority language, it is important to examine its impact on newcomers. Prior research on second-language interaction and access to services has found that clients prefer communicating in their native language, as it allows them to express emotions, articulate problems, and reflect on situations more thoroughly (e.g., [38]). When this is not possible, anxiety often arises, particularly among children, seniors, and their caregivers [39]. Professionals also report challenges: focus groups with seventy-two bilingual practitioners in Canada revealed that they often bear the burden of assisting clients in minority languages due to limited bilingual staff [40]. Similarly, a national study in Wales found that offering language choice was highly valued as a sign of cultural sensitivity; health professionals described speaking Welsh as creating a bond with patients and even suggested formal Welsh language training for staff [41].

### **2.1.2 Social and Psychological Barriers**

Beyond linguistic challenges, integration also involves psychological and social dimensions, including not only meeting basic needs but also feeling accepted and connected. An important aspect of well-being is a sense of *belonging*, the absence of which can lead to stress and uncertainty. Hagerty et al. [42] defined it as “*the experience of personal involvement in a system or environment so that persons feel themselves to be an integral part of that system or environment. A system can be a relationship or organization, and an environment can be natural or cultural*”.

In a recent study of Chinese international students in the UK, it was found that social interactions, along with a sense of belonging, were positively linked to psychological well-being [43]. Similarly, research using the concept of *Connected Belonging* has shown that strengthening individuals’ sense of belonging can enhance well-being, particularly among female students [44]. Outside higher education contexts, research with children of international migrants exploring their sense of *home* revealed that fostering familial bonds during integration helps maintain hope and envision a better future [45].

These findings highlight the importance of designing support systems that foster not only functional assistance but also a sense of social integration and belonging.

### 2.1.3 Structural and Logistical Barriers

In addition to linguistic and social barriers, refugees and asylum seekers often face structural barriers that complicate these processes. These include experiences of homelessness [46] and, for those applying for asylum, what has been described as “*being kept in a perpetual limbo*” [47], sometimes involving prolonged detention or even expulsion [48]. Communication challenges can further compound these difficulties, as many newly arrived individuals are not fluent in the host country’s language and often rely on cultural mediators such as integration advisors [49]. A further shared experience is navigating bureaucratic processes, requiring significant time and energy for appointments and paperwork [50].

Such barriers are particularly evident when navigating bureaucratic systems and accessing services. Administrative complexity can heighten stress during such interactions, especially when newcomers have limited proficiency in the host country’s language. In some cases, institutional support mechanisms attempt to mitigate these difficulties. For example, US universities offer programs to enhance English language proficiency and workshops on American classroom expectations [37]. Similarly, a UK survey of 1,425 international students found that 46.2% identified financial assistance (e.g., hardship funds) as their top priority, while 35.6% highlighted the need for support with navigating bureaucracy (e.g., registering with a doctor or opening a bank account) [51]. For displaced populations, challenges extend beyond education: in the UK, rights vary by legal status, and restrictive access to healthcare is common [52]. Across Europe, similar barriers persist, with language, legislation, and financial constraints frequently cited as major obstacles to healthcare access [53].

At a system level, these challenges are exacerbated by resource constraints. The growing demand for services, both in the UK and globally, is outpacing the available workforce. In 2023, for example, it was reported that UK social workers are leaving their posts in record numbers [54], which poses a problem as there is increasing demand and declining resources [55]. There is also a decline in the number of qualified nurses and midwives [56], alongside chronic underfunding of social care services over the past decade [57].

## 2.2 Technological Solutions for Multilingual Accessibility

In the previous subsection we discussed the growing demand for services side by side with a growing shortage of staff, a challenge that is far from new. Technological innovations have long been introduced to address such gaps: for example, the rise of the internet enabled customers to book flights online in the early 2000s [58]. While websites might suffice for simple tasks like form-filling or providing static information, more complex needs often require advanced solutions.

The idea of machines engaging in conversation dates back to Alan Turing’s seminal paper, which introduced a thought experiment about whether machines could answer questions and

imitate human intelligence [59]. This concept moved from theory to practice with ELIZA, developed by Joseph Weizenbaum [60], one of the earliest programs to simulate conversation. ELIZA's most famous script, DOCTOR, emulated a Rogerian psychotherapist by reflecting users' statements and emotions [61]. Since then, dialogue systems, also known as chatbots or conversational agents (CAs), have evolved significantly, from early call center chatbots to voice-based assistants such as Apple's Siri and Amazon's Alexa, which are now widely used for a variety of everyday tasks worldwide. More recently, with the introduction of Large Language Models (LLMs), such as OpenAI's ChatGPT and Anthropic's Claude, they are now the ultimate personal assistants.

Conversational agents are deployed within economic and social constraints, which are especially evident in multilingual healthcare settings. In the UK, the National Health Service (NHS) spent £64 million on translation services in the financial year 2024-2025. This estimate is drawn from a newspaper report based on Freedom of Information requests [62]. Despite this significant investment, qualitative research on asylum seekers' experiences highlights persistent challenges, including long waiting times and concerns about the qualifications of interpreters [63]. These findings suggest that while human translation services are essential, they are costly, difficult to scale, and vary in quality, particularly in high-demand contexts.

In response to these limitations, organizations increasingly adopt conversational agents to support or partially replace human mediation for customer interaction and internal operations [64]. Recent work suggests that multilingual conversational agents can help reduce language barriers through automatic translation [65]. However, empirical evidence indicates that their real-world effectiveness can be mixed; for example, in call centers, AI-based conversational agents may increase average call duration rather than reduce workload [66]. This suggests a deeper limitation in current approaches to multilingual accessibility. Neither human translation services nor automated conversational agents consistently deliver high-quality interactions in practice.

A CA typically consists of five core components [67], as illustrated in Fig. 2.1: automatic speech recognition (ASR), natural language understanding (NLU), dialogue management (DM), natural language generation (NLG), and text-to-speech (TTS). The process begins with ASR, which converts spoken input into a representation that can be further processed by NLU. NLU extracts all relevant information from the utterance and passes it onto DM for further processing. DM controls the structure and flow of the dialogue, tracks information that has already been provided, and takes care of the interaction with relevant backend systems. Based on user input and backend data, it specifies the system's response, which is then converted into language by NLG and into speech by TTS.

More than 300 million people use Duolingo, a gamified (through a game) app for learning about 95 different languages [68]. In the same vein, CAs have been widely applied in language learning to teach majority languages and support or replace teachers. Examples include Gen-

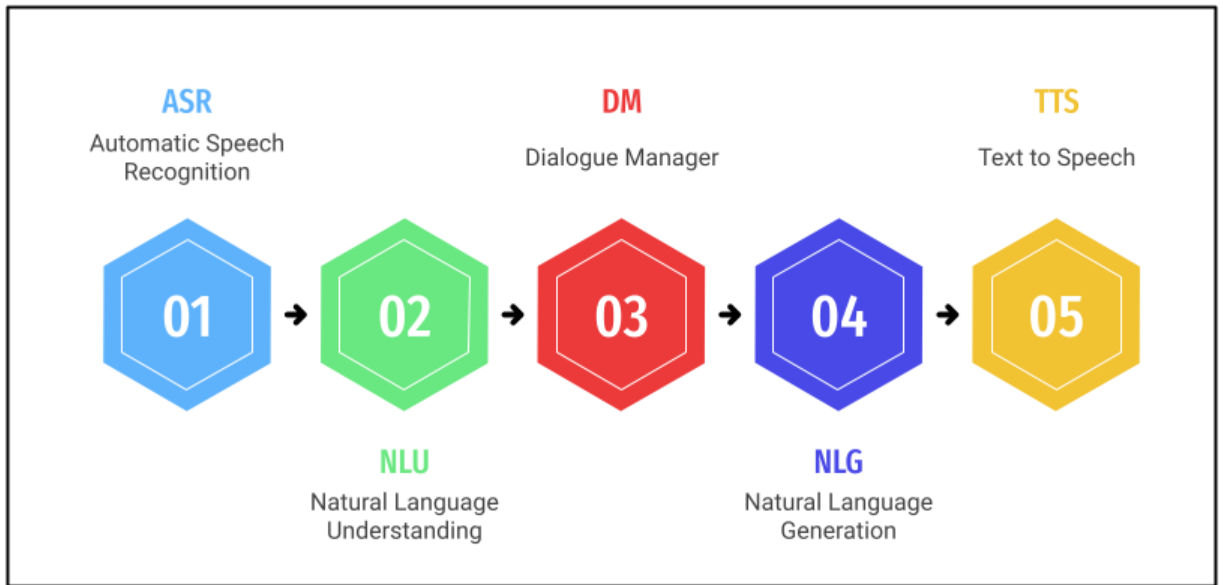


Figure 2.1: CA components: ASR, NLU, DM, NLG, and TTS

gobot, which teaches Japanese to English and Indonesian speakers [69], and a chatbot which provides grammar feedback in English [70]. A recent survey of 25 empirical studies found that, although the long-term effects remain underexplored, chatbots can improve students' grammar, listening, and writing skills [71]. Moreover, chatbots can also support learners emotionally, as shown in a study where participants reported reduced anxiety after several weeks of learning English with a chatbot [72]. Accessibility via personal devices is a key factor motivating users to engage with chatbots for foreign language practice [69].

Furthermore, CAs have been applied in other use cases, notably in health interventions. For example, Layla was co-designed through four focus groups with 31 women to help prevent unintended births among Black and Hispanic teenage girls [73]. During the COVID-19 pandemic, another chatbot was developed for daily screening of healthcare workers, with stakeholder interviews informing workflow and product requirements [74]. Similarly, a chatbot in Brazil was designed to make blood donation information more accessible, and researchers consulted relevant stakeholders during its development [75]. Research suggests that, unlike doctor-patient relationships where bias based on gender, age, or race can occur, chatbot-patient interactions may be less susceptible to such bias, at least from the patient side [76]. These findings highlight the importance of guiding digital health innovations with research that evaluates their impact, ensures user safety, and promotes well-being [77].

Just as technology has been leveraged for health interventions, it is also shaping migration-related interventions. A survey of 282 research publications from 2010 to 2019 demonstrates the breadth of research of Human-Computer Interaction (HCI) and international migration [78]. Key areas include *Digital Literacy and Access* (12.5%), *Social Inclusion* (12%), and *Service Access* (12%), the latter focusing on how newcomers navigate government services. Despite this progress, the authors note that HCI research on migration remains exploratory, given its

limited technological focus and number of intervention studies.

Recent work has introduced chatbot assistants, such as bilingual *SALLY* supporting migrants in Greece [79] and the multilingual *MyWelcome Agent* acting as a personal assistant [80] - both still prototypes. However, these online solutions risk distancing migrants from aid agencies and may spread misinformation if data becomes outdated [81].

Building on these early efforts, a recent study evaluated three widely used generative LLMs: OpenAI's ChatGPT, Microsoft's Copilot, and Google's Gemini. The comparison focused on queries related to Canadian government services and was conducted without any customization. Researchers favored ChatGPT because it consistently began responses with an introduction that reiterated the user's question. However, the study did not include user testing and appears not to have assessed multilingual capabilities [82].

## 2.3 Social Robots as Supportive Embodied Agents

Social Robots are a form of Embodied Conversational Agents (ECAs), a broader category that also includes digital avatars. One of the earliest researchers to explore this domain was Kerstin Dautenhahn, who argued that effective communication is of far greater importance than a robot's appearance for successful integration into human society [16]. Socially interactive robots, as embodied agents, can engage in both verbal and non-verbal communication. Fong et al. [83] describe two main design approaches: *biologically inspired*, which draw on forms found in nature, and *functionally designed*, which prioritize functionality and may be non-anthropomorphic. Appearance matters because it can influence interaction bias; for example, a robot that looks like an animal may be treated differently than one with a human-like form.

A well-known example of a *biologically inspired* robot is Paro, a baby seal robot developed in Japan and commercialized since 2005 as a companion for older adults [84]. Research shows that Paro can provide comfort, encourage social interaction, and enhance emotional engagement among older adults [85]. Interestingly, individuals with social anxiety often prefer interacting with robots rather than humans [86]. Despite these benefits, ethical concerns remain, particularly regarding the risk of deceiving dementia patients with a device that mimics life [87]. Unrealistic expectations can also lead to frustration; for example, some users have tried placing Paro in water to see if it could swim, given its seal-like appearance [88]. More broadly, similar patterns of overtrust and misinterpretation have been observed in socially interactive robots, where users may attribute greater intelligence or understanding to the system, particularly in sensitive contexts [89].

Prominent humanoid robots that have been extensively studied include Furhat [17], Pepper [90], and NAO [91] (Fig. 2.2). Furhat is capable of facial expressions but lacks a body, whereas Pepper and NAO have bodies (with NAO featuring legs) but lack expressive faces. According to the Anthropomorphic roBOT (ABOT) database, which measures human-like appearance, Furhat

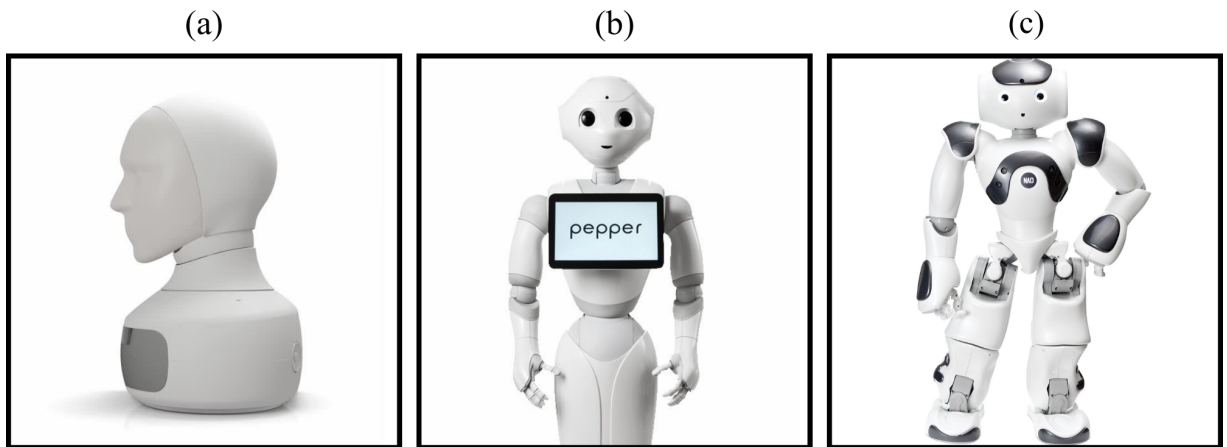


Figure 2.2: Common humanoid social robots: (a) Furhat; (b) Pepper; (c) NAO

scored higher than Pepper and NAO [92]. This high level of anthropomorphism may evoke the Uncanny Valley effect [93], a phenomenon where robots that appear highly human-like but behave unnaturally can cause discomfort. For example, a smile can seem pleasant, but a slowly appearing smile might feel disturbing [94]. Building on earlier research on the role of appearance in shaping interaction, a lab study explored how robot form influences user responses by deploying an identical chatbot system onto Furhat and Pepper. Eighteen participants rated Furhat as better at displaying emotions and appearing more intelligent and trustworthy than Pepper [18].

It is difficult to claim that physically embodied robots are significantly better than voice-based assistants on tablets or speakers. The Embodiment Hypothesis is defined as “*physical embodiment has a measurable effect on performance and perception of social interactions*” [95]. A survey of 33 studies found that people responded differently to physically present agents, showing stronger behavioral and attitudinal reactions compared to virtual agents [96]. Another review of 65 studies reported strong support for embodiment in task performance with socially interactive robots, although the differences were not statistically significant [97]. Contradicting both, a recent meta-analysis of 34 user studies found no significant differences, suggesting that embodiment may not be as critical as previously thought. However, most participants in these studies were under 35, so findings primarily reflect younger populations. The authors recommend that designers strategically use both physical and non-physical modalities depending on application needs and user context [98].

While debates about embodiment inform design choices, practical challenges in care settings highlight the need for technological solutions that support rather than replace human workers. In Japan, robots have been developed to assist the elderly population. However, a study in a Japanese care home revealed that staff had more complaints than praise; e.g., “*staff stopped using Hug after only a few days, saying it was cumbersome and time consuming to wheel from room to room, cutting into the time they had to interact with the residents*” [99]. Instead of

reducing workload, maintaining the robots became an additional burden.

A survey of robotics publications from 2015 to 2020 found that older adults generally did not want their caregivers replaced by robots [100]. However, some professionals see potential benefits; as one geriatric nurse noted, “...they help when no one else is there to help.” [101]. Similarly, nurses in a US study envisioned robots as tools to empower them when confronting unsafe physician behavior, thereby improving patient safety [102].

The e-VITA project extended this approach by developing a virtual coach for community-dwelling older adults through participatory design and home-based studies in Europe and Japan. It combined conversational agents with multimodal interaction and provided multicultural and multilingual support across four languages in health and elder-care contexts. The project suggests that such systems are most viable when they complement, rather than replace, human support [103, 104].

Beyond physical assistance, social robots are also being explored for emotional support. One recent study introduced a long-term intervention to help informal caregivers manage emotional distress through self-disclosure to a social robot. Over five weeks, caregivers interacted with a humanoid in ten sessions, discussing everyday topics. Findings revealed that caregivers became more open, perceived the robot as social and competent, and reported improved moods. They also felt less lonely and stressed. Post-intervention, participants expressed greater acceptance of their caregiving roles, reappraised them more positively, and experienced reduced feelings of blame toward others. These results underscore the potential of social robots to provide emotional support for individuals facing caregiving-related stress [105].

Building on these findings, language is another critical factor for fostering a sense of belonging. Most social robots use the dominant language of the country where they were developed and often adopt “standard” accents such as General American or Standard Southern British English [106], regardless of local dialects. Recently, a few bilingual or multilingual robots have emerged. For example, an Arabic-English speaking robot explored speech across Arabic and Western cultures [107], Hala the receptionist spoke Arabic and English [108], and a NAO robot read Wikipedia entries in Japanese and English [109]. However, these robots were generally designed for interaction rather than a specific functional purpose.

Another area where robots may speak more than one language is Robot-Assisted Language Learning (RALL). A recent survey of 33 studies found that most focused on word learning and were not highly effective, yet both children and adults often enjoyed interacting with the robot [110]. Similarly, another review of 22 studies reported that over 91% of coded emotional responses were positive [111]. RALL belongs to the broader field of educational robotics. A survey of 309 studies showed that 86% of robots were designed to serve as teachers or tutors and that 58% targeted children [112]. Language acquisition in children is inherently social, which means robots need to respond contingently and multimodally. However, most systems manage dialogue through a tablet interface, similar to a chatbot. This limits responsiveness to nonverbal

cues and often leads to breakdowns in interaction [113].

These limitations underscore the need for participatory design, which involves end-users in the development process to create systems that reflect their needs and preferences. This approach has become common practice, engaging diverse groups such as older adults [114], children [115], and blind people [116]. Chatbots and robots can provide valuable support, but developers must ensure these systems meet the linguistic needs of their target populations and avoid reinforcing biases from language and speech technologies. For example, ASR systems have shown performance gaps between white and Black speakers because they were not trained on African American Vernacular English [117]. A recent survey of 146 papers further highlights widespread issues with bias and poor methodology in language technologies [118]. In robotics, these challenges extend to user expectations, people often assume robots will speak standard American or British English and fear they will not be understood if they use non-standard dialects [106].

## 2.4 Social Robots Deployment in Real-World Settings

Social robots are increasingly deployed in public spaces, defined as “*anywhere that groups of people who may or may not know each other can freely assemble, move about, and interact*” [119]. For over two decades, researchers have argued that studies should move beyond controlled laboratory settings and into real-world environments [120, 20]. These environments pose significant technical challenges, but they also offer more authentic and realistic application areas and evaluations [4]. Notably, people are not yet accustomed to encountering robots in public. In one study, a few users mistook Pepper for a queue number machine and tried to use its tablet to get a train ticket. Such incidents led researchers to conclude that, at present, people are not ready for open-ended, in-the-wild interactions [21].

Examples of use cases include the Furhat robot acting as a receptionist [6], a museum guide [7], and a barista [8]. Pepper has also been deployed in diverse contexts such as shopping malls [121], restaurants [122], libraries [19], university buildings [123], and train stations [21]. User responses to these robots have generally been positive; however, technical limitations in audiovisual sensing within public spaces can negatively affect performance, and many studies are influenced by the novelty effect [124].

In a review of 30 studies on NAO and Pepper robots in public settings, researchers found that education was the most common domain, and tasks often focused on providing information. They also emphasized the importance of managing conversations with multiple people and incorporating non-verbal cues during interactions [19]. More recently, researchers deployed trash barrel service robots in public spaces to study Human-Robot Interactions (HRI) and develop practical guidelines for future deployments [22]. The robots were tested under laboratory conditions before being deployed in-the-wild. Based on their experience, the authors recommend

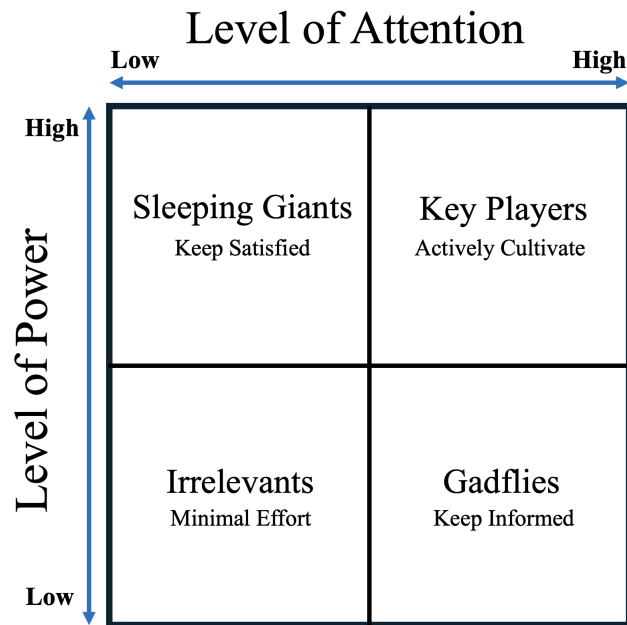


Figure 2.3: Stakeholder Mapping [1, 2]

avoiding “*debugging in the field*”, while acknowledging that this is not always feasible, and highlight challenges such as selecting appropriate deployment sites and obtaining permission for public deployment.

Deploying a robot in a public space normally involves integrating it into an existing workplace, as in the deployments listed above. In these environments, robots are increasingly positioned not only as technical tools but as interactive agents and potential co-workers within service systems [125]. This process requires consultation with multiple stakeholders, including management, visitors, and front-line workers, to define the details of the system [126]. Managers are particularly influential: no deployment can ethically occur without their permission, and they control key factors such as timing, location, and interaction topics (e.g., [127]). At the same time, success is often evaluated through user behavior and subjective responses (i.e., building visitors) [128]. However, input from other stakeholders, especially front-line workers, is equally critical. Without their feedback, deployments are unlikely to succeed. While some workers may initially fear being replaced, the most productive model is collaborative, where robots assist with tasks and free workers for others [129].

To systematically address these dynamics, researchers propose a stakeholder framework based on power and interest [1], adapted from social analysis [2]. The framework uses a matrix with one axis representing the level of *power* or influence and the other representing the level of *attention* or interest (Fig. 2.3). Stakeholders are categorized into four groups: (1) *Key Players*, including main users and front-line workers, who hold the greatest influence; (2) *Sleeping Giants*, such as managers, who should be kept informed and engaged; (3) *Gadflies*, workers who can influence key players or mobilize managers; and (4) *Irrelevants*, visitors with minimal

influence on decision-making.

One practical approach to engaging stakeholders throughout the design process is Participatory Design (PD). It is often conceptualized as a three-stage co-design strategy: (1) meeting the users; (2) clarifying their goals and desired outcomes; and (3) creating a prototype or developing design guidelines [130].

This approach has become common in social robot design, engaging diverse user groups such as older adults [114], children [115], and blind individuals [116], among others. In some cases, researchers include all relevant stakeholders, as in Sienkiewicz et al. [131], who engaged in PD activities with older adults, caregivers, medical professionals, and psychologists. PD processes can vary in duration, ranging from short sessions lasting several hours to long-term studies, such as a year-long project with 28 older adults aimed at fostering a deeper understanding of the robot [132].

While PD is often associated with iterative co-design processes, it can be adapted to the constraints of specific settings, especially when working with hard-to-reach or vulnerable populations. In this thesis, participatory engagement was therefore adopted pragmatically through two focus groups with refugees and asylum seekers rather than repeated co-design workshops. Following work on PD with vulnerable groups, engagement is treated as occurring at different stages of the project rather than as a requirement for continuous iterative co-design cycles [133]. This approach is discussed further in Chapter 3.

## 2.5 Summary and Gaps

This thesis addresses the gaps identified in the literature by developing a multilingual support robot designed to work alongside human support workers assisting newcomers. The robot was deployed in public spaces, interacting with users in their native languages across two settings: (1) a student services center and (2) a drop-in service for refugees and asylum seekers. Each design and deployment process was guided by consultations with key stakeholders to ensure contextual relevance.

The thesis presents two tailored applications of the robot, each evaluated using complementary methods. Chapter 4 describes its use with international students at the University of Glasgow, assessed through a controlled lab study and an in-the-wild deployment. Chapter 5 details its adaptation for refugees and asylum seekers at a charity drop-in service, informed by a co-design process with Syrian refugees and later evaluated through an in-the-wild study. Chapter 6 synthesizes lessons learned and offers guidelines for future deployments of social robots. Through these applications, the thesis demonstrates the potential of multilingual support robots and provides actionable recommendations for their integration into public service environments.

# Chapter 3

## Methodology

This chapter outlines the methods used to conduct the studies presented in this thesis. It begins with an overview of the robot, the study design, and the information pipeline, followed by a description of the data collection process. It then presents the overall research approach and concludes with a reflection on ethnography and the researcher’s positionality.

### 3.1 Robot and Study Design

The multilingual robotic system used in our user studies is based on the Furhat Robotics platform. This social robot features a human-like head that projects an animated face onto a 3D semi-translucent mask [17]. Although Furhat is less widespread and studied than Pepper [90] and NAO [91] (Fig. 2.2), it ranks higher in anthropomorphic appearance according to the ABOT database [92]. Its distinctive design enables rich social cues, such as gaze behavior [134, 135], and supports extensive customization of attributes like age [136], ethnicity [137], and gender [138]. Furthermore, Furhat offers multilingual capabilities with support for over 120 languages and 200+ voices [139].

We developed a multilingual robotic system that incorporates the Furhat robot, an Amazon Kindle Fire tablet, and a microphone (Fig. 3.1). The system runs custom Python software and leverages OpenAI APIs for various tasks [140]. As shown in Fig. 2.1, it comprises modules for Natural Language Understanding (NLU), Dialogue Management (DM), and Natural Language Generation (NLG). Furhat captures user speech through its microphone and performs Automatic

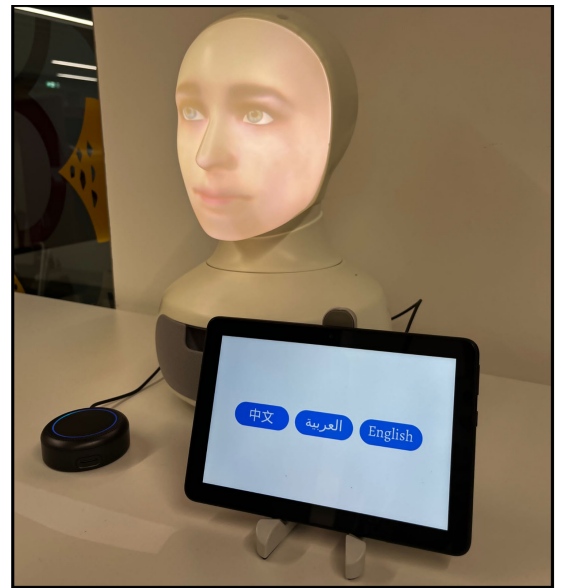


Figure 3.1: The robotic system

Speech Recognition (ASR) using Google Cloud Speech-to-Text [141], converting spoken input into text in Modern Standard Arabic, English, or Mandarin Chinese. For Text-to-Speech (TTS), the system employs three neural voices from Amazon Polly: Hala (Gulf Arabic), Zhiyu (Mandarin Chinese), and Amy (British English) [142, 143]. These female voices were selected for their superior perceptual quality across the target languages. The robot’s visual appearance uses the Fedora character, widely adopted for its feminine look [e.g., 144, 138, 145], and selected for its ethnically neutral design, which enhances the plausibility of multilingual interaction for both international students and refugees.

The interaction begins using the tablet, where users select their preferred language: English, Mandarin Chinese, or Modern Standard Arabic. After the selection, Furhat initiates the dialogue in the chosen language. Each session concludes with a QR code that directs users to additional information in their preferred language. We developed corresponding ad-hoc HTML pages for these QR codes to provide technical details in an accessible format. To maintain engagement and avoid cognitive overload, the spoken interaction was kept brief, with the QR code serving as a gateway to further resources. Fig. 3.2 illustrates a sample interaction in English; the Mandarin Chinese and Modern Standard Arabic versions follow the same structure.

The interaction design was also shaped by practical considerations in public settings. The presence of long queues and time constraints required interactions to be brief while still delivering useful outcomes. Short, task-oriented exchanges were therefore prioritized to minimize waiting time and maintain throughput. Prior work has shown that user preferences for dialogue length can vary depending on contextual and cultural factors [146], making it challenging to design a universally optimal level of verbosity. In this context, shorter responses were chosen as a robust and inclusive design strategy, reducing cognitive load and minimizing the risk of misunderstanding in multilingual interactions. As a result, more socially rich dialogue features,

<p>STUDENT: [The user clicks on “English” on the tablet]</p> <p>SYSTEM: How can I help you?</p> <p>STUDENT: Will robots take over the world?</p> <p>SYSTEM: Unlikely, it’s a sci-fi concept. How can I help you?</p> <p>STUDENT: I’m looking for a building in the campus.</p> <p>SYSTEM: Where would you like to go?</p> <p>STUDENT: The admissions office, please.</p> <p>SYSTEM: For a map to the admissions office, please scan the QR code below. [After 5 seconds] Have you scanned the QR code?</p> <p>STUDENT: Yes, thank you.</p> <p>SYSTEM: Can I help you with anything else?</p> <p>STUDENT: No, that will be all.</p> <p>SYSTEM: I would appreciate it if you’d rate our conversation by clicking on the tablet. Thank you and have a lovely day.</p> <p>STUDENT: [The user clicks on a “happy” emoji on the tablet]</p>
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Figure 3.2: Sample interaction between a student and the Furhat robot

such as extended greetings or multi-turn clarification exchanges, were intentionally not prioritized, as they would increase interaction length and could hinder efficiency and accessibility in time-constrained public settings.

## 3.2 Language Processing and Information Pipeline

The multilingual interaction system integrates several language processing components to support task-oriented dialogue in public settings. User speech is first converted to text via Automatic Speech Recognition, after which the system processes the input through a Natural Language Understanding module. In most cases, large language models (LLMs) are not used for end-to-end systems, but separately for intent classification and response generation, enabling the system to determine the appropriate dialogue state and response in separate processing steps.

In both use cases, dedicated Python programs were developed to control the Furhat robot via the Furhat Remote API, enabling external management of dialogue and system behavior rather than relying on built-in Furhat skills. In the student services use case, the dialogue manager follows a state-machine-based design, guiding users through predefined information tasks and retrieving responses from verified information sources curated by the support team. In cases where users ask questions outside the predefined scope, the LLM generates short responses combined with task-relevant prompts, maintaining focus on the overall interaction.

In the refugee and asylum seeker (RAS) use case, the system incorporates a Retrieval-Augmented Generation (RAG) approach. Relevant service information is retrieved from structured datasets (e.g., food hubs and libraries) based on user input, such as postcode prefixes, and presented through QR-linked web pages. This design prioritizes retrieval over generation to reduce the risk of hallucination and ensure that information remains grounded in verified external sources.

To further mitigate risks associated with LLM-based systems, such as hallucination or misinformation, all core service content was pre-validated and stored outside the language model. The role of the LLM is therefore constrained to classification and limited conversational support, rather than autonomous content generation. This hybrid architecture enables flexible interaction while maintaining reliability and transparency in public service contexts.

## 3.3 Data Collection

To assess user experience and perceived helpfulness, three subjective measures were collected.

First, after each support interaction, the participant was prompted to give immediate feedback (Task Feedback) by clicking an emoji to indicate either “Happy”, “Neutral”, or “Sad” on the tablet, as shown in Fig. 3.3. The use of emoji-based Likert scales is a common practice in user satisfaction surveys (e.g., [147, 148]).

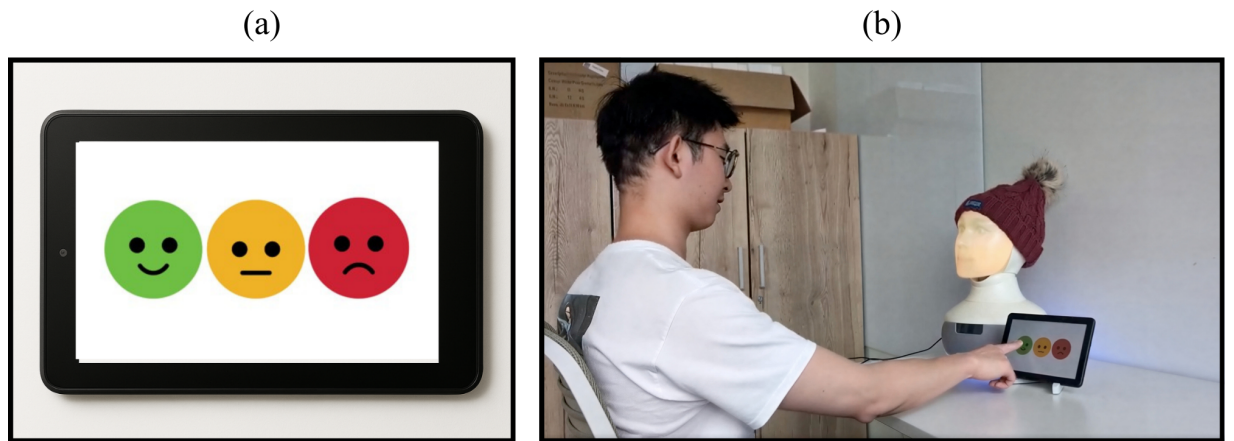


Figure 3.3: Task feedback: (a) Emoji-based Likert scale; (b) A participant giving feedback

Second, participants completed a survey using a subset of the SASSI questionnaire [149], which is a validated subjective questionnaire designed to measure user satisfaction with speech-based systems. We included items from three sub-scales of the SASSI questionnaire; the complete list of statements is provided in Table A.1 in the appendix:

1. **Cognitive Demand** (5 items): the perceived amount of effort needed to interact with the system and the feelings resulting from this effort. E.g, *I felt tense using the robot.*
2. **Habitability** (4 items): the extent to which the user knows what to do and knows what the system is doing. E.g, *I always knew what to say to the system.*
3. **Likeability** (9 items): the user’s ratings of the system as useful, pleasant and friendly. E.g, *The system is friendly.*

Participants rated each item on a 7-point Likert scale, with items presented to each participant in a random order. Scores for each sub-scale were averaged to produce an overall score for the corresponding SASSI factor.

Lastly, the survey included a single-item question on perceived helpfulness: *Was the robot helpful?*, with response options “Yes”, “Maybe”, and “No”.

### 3.4 Research Approach

Most HRI research is conducted with participants from so-called “WEIRD” (Western, Educated, Industrialized, Rich, and Democratic) societies, meaning that systems are typically designed for and evaluated on users familiar with WEIRD communication norms [150]. This thesis aims to explore interactions with a support robot among diverse users in real-world contexts. Using a mixed-methods approach, we deployed and evaluated the robot in public spaces where it interacted with users in their native languages. The system was tested in two use cases: (1) supporting

newly arrived international students at the University of Glasgow by answering frequently asked questions, and (2) assisting RAS in navigating bureaucratic processes.

Consistent with the participatory design perspective introduced in Section 2.4, this research adopted a pragmatic form of participatory engagement. Rather than following iterative co-design cycles, participatory elements were integrated through stakeholder consultation, focus groups with RAS, and ethnographic observation of service interactions. These activities correspond to key stages of participatory design, including engaging users, understanding their needs in context, and informing system design decisions.

In practice, recruitment and sustained engagement with RAS participants were shaped by contextual constraints; for example, the first focus group (n=6) took place in December 2024 during the fall of the Assad regime, and the second (n=3) in March 2025 during Ramadan. These conditions affected participant recruitment, while the circumstances of the RAS population, including limited availability and the challenges of coordinating participation, made repeated co-design sessions difficult to organize. The role of these participatory elements within the research process is further detailed in the following section.

### **3.5 Ethnography and Positionality**

To complement the technical evaluation, this study draws on insights from sociolinguistics and ethnographic methods to examine the social dynamics surrounding robot interactions. Ethnography is “*the study of social interaction and cultural groups, whether these groups are defined as societies, communities, organizations, or teams*” [151]. One common ethnographic method is *participant observation*, in which the researcher “*engages in the participation actively with a general commitment to observing everyday social life*” [151]. A more embodied approach, *observant participation*, positions the researcher as an insider, enabling access to less visible practices and spaces that are difficult to reach through participant observation alone [152].

The ethnographic component of this research emerged iteratively as the focus on newcomers required a deeper understanding of their everyday interactions with public services. Initially, the study aimed to investigate the needs of RAS; however, gaining access to this population required establishing trust and institutional connections. The researcher therefore began by engaging with a more accessible group, University of Glasgow international students, through collaboration with university support services, conducting observations of staff-student interactions and consulting with service providers. In parallel, to gain access to RAS populations, the researcher volunteered with a community organization supporting these groups. This progression allowed the research to develop an ethnographically informed approach grounded in both observation and direct engagement, shaping the methodological choices described below.

In this thesis, two use cases illustrate these approaches:

1. **Student services center:** The researcher acted as a participant observer, conducting observations of student support staff while they provided services to international students.
2. **Drop-in service for RAS:** The researcher acted as an observant participator by volunteering with the *Central and Western Integration Network (CWIN<sup>1</sup>)*, a Scottish charity supporting refugees, asylum seekers, and migrant workers throughout Glasgow. This role enabled the researcher to engage directly with the drop-in service to better understand the needs and experiences of the RAS populations.

CWIN, as a support system, and the RAS themselves are regarded as socially disadvantaged groups. These groups are often referred to as “*hard-to-reach populations*” since they are difficult for researchers to access and are commonly excluded from health and medical studies [153]. A “smash-and-grab” approach, where researchers engage briefly to collect data and then leave, would have been both unethical and impractical [154]. Instead, this study required building professional relationships and trust with participants.

Although not part of the initial study design, the analysis of stakeholder roles and interactions was subsequently informed by a stakeholder framework based on power and interest (Fig. 2.3). In this framework, stakeholders are categorized into four groups: (1) Key Players, (2) Sleeping Giants, (3) Gadflies, and (4) Irrelevants. Applied retrospectively, the framework provided a useful lens for interpreting the researcher’s experiences across the two use cases. In particular, it helped to differentiate the roles and influence of stakeholders such as managers, front-line workers, and users, and to understand how these relationships shaped the deployment and evaluation of the robot. This retrospective application of the framework enabled a more structured and nuanced interpretation of the findings.

Finally, it is important to acknowledge this researcher’s positionality. The researcher is an Israeli with a mixed Jewish heritage of Egyptian, Syrian, and Hungarian descent. His family history, which includes displacement from Arab countries and relatives who survived the Holocaust, shaped a strong personal connection to the study’s focus on newcomers and displaced individuals. He moved to Scotland to pursue PhD studies, and during the period of data collection, the war in Gaza that began on 7 October 2023 was ongoing. This context introduced challenges in conducting the research and recruiting Arab participants. Negotiating his identity as the visible face of the project sometimes led to difficulties and occasional suspicion from both university students and refugees.

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<sup>1</sup><https://www.cwin.org.uk>

# Chapter 4

## The Multilingual Student Support Robot



Figure 4.1: The robot system

### 4.1 Chapter Introduction

This chapter explores how social robots can assist international students in navigating university support services during their initial weeks in the UK. While previous work has examined multilingual interfaces in educational contexts, newly arrived students often face unique challenges, including language shock and bureaucratic complexity. To address these issues, we present the design and evaluation of a multilingual support robot that communicates in English, Mandarin Chinese, and Modern Standard Arabic. Through two complementary studies: (1) a controlled lab experiment and (2) an in-the-wild deployment, we investigate user needs, language preferences, and real-world performance in authentic university settings.

### 4.1.1 Motivation and Related Work

One out of four students in the UK is an international student, and the vast majority (87%) come from non-EU countries. Their numbers continue to rise: in 2024, non-EU international student enrollment increased by 20% compared to the previous year [155]. UNESCO defines international students as *individuals who have physically crossed an international border between two countries with the objective to participate in educational activities* [156]. These students make a substantial economic contribution, with an estimated net impact of £37.4 billion [157]. The top non-EU countries of origin for the academic year 2022/23 include India, China, the UAE, and Saudi Arabia [158].

A sense of belonging is vital for well-being, and its absence can lead to isolation and insecurity [45]. This is particularly relevant for newcomers such as international students [159], who often face challenges when interacting with university support services. Although all meet English proficiency requirements for admission, many struggle with everyday communication during their first weeks in the UK. They frequently experience culture shock [160] and, more specifically, language shock [161]: the informal, context-specific English they encounter often differs from what they learned at home. These difficulties arise precisely when students must navigate complex bureaucratic processes to settle in and begin their studies.

To address these challenges, prior work has explored technology-based solutions for student support. Examples include Valerie, a receptionist avatar assisting students in English and Brazilian Portuguese [162]; a prototype multilingual support system using translation mechanisms [163]; a Nao robot supporting time management and role organization [164]; and a Pepper robot providing campus guidance and information [123, 165]. While these systems demonstrate the potential of social robots and multilingual interfaces, few have focused on addressing bureaucratic challenges for newly arrived international students.

To bridge this gap, we focus on the broader goals outlined in RQ1, RQ2, and RQ3, applying them to the context of international students. To operationalize these goals, we formulated the following study-specific research questions:

- RQ1a** Which services do international students need, and how do they currently access them?
- RQ2a** To what extent are human support services for students willing to integrate social robots into their offerings?
- RQ3a** Do international students prefer accessing services in their native language, even when provided by a robot?

We developed a multilingual student support robot that communicates in Mandarin Chinese, Modern Standard Arabic, and English. Designed for deployment in the University of Glasgow's

student service center alongside human staff, the robot answers questions on four frequently requested topics: *campus directions*, *local tax exemption*, *financial aid*, and *official documents*.

## 4.1.2 Chapter Structure

This chapter begins by presenting the motivation, methods, and evaluation approach through two complementary studies. It then discusses stakeholder consultations and observations of the support staff. Next, it describes the lab study, outlining its hypotheses, results, discussion, and conclusions. The following section covers the in-the-wild study, including its results, discussion, and conclusions. Finally, the chapter concludes with a summary of key findings.

## 4.1.3 Methods

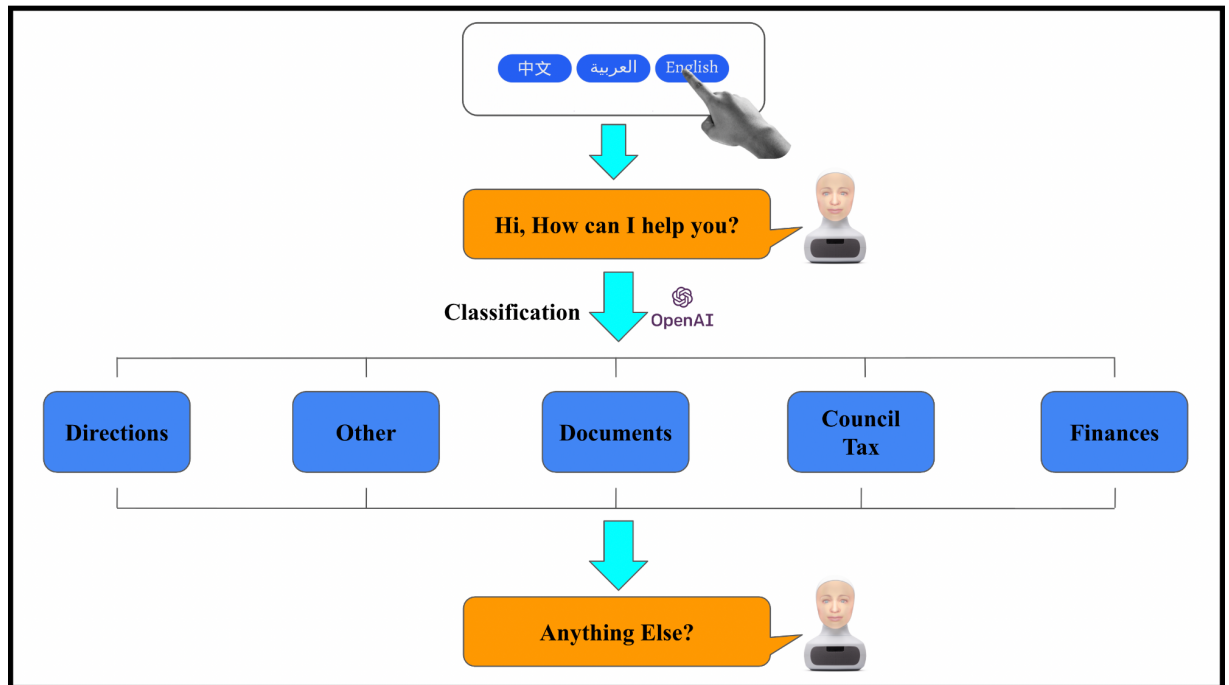


Figure 4.2: The dialogue state machine (high-level)

The robotic system (Fig. 4.1) is described in Section 3.1. The dialogue manager was implemented in Python [166] as a state machine [167], guiding users through a task-based conversation (Fig. 4.2). States requiring Natural Language Understanding use OpenAI [140] to classify user intent and determine the next step. This integration adds flexibility and robustness against speech-recognition errors in public settings. When users ask questions outside the predefined domain, OpenAI generates a brief answer followed by a task-relevant prompt, enabling limited social interaction within the overall task-oriented dialogue.

All information provided by the robot was verified by the student support team. To ensure linguistic accuracy, the researcher created HTML pages for each sub-topic, which were then

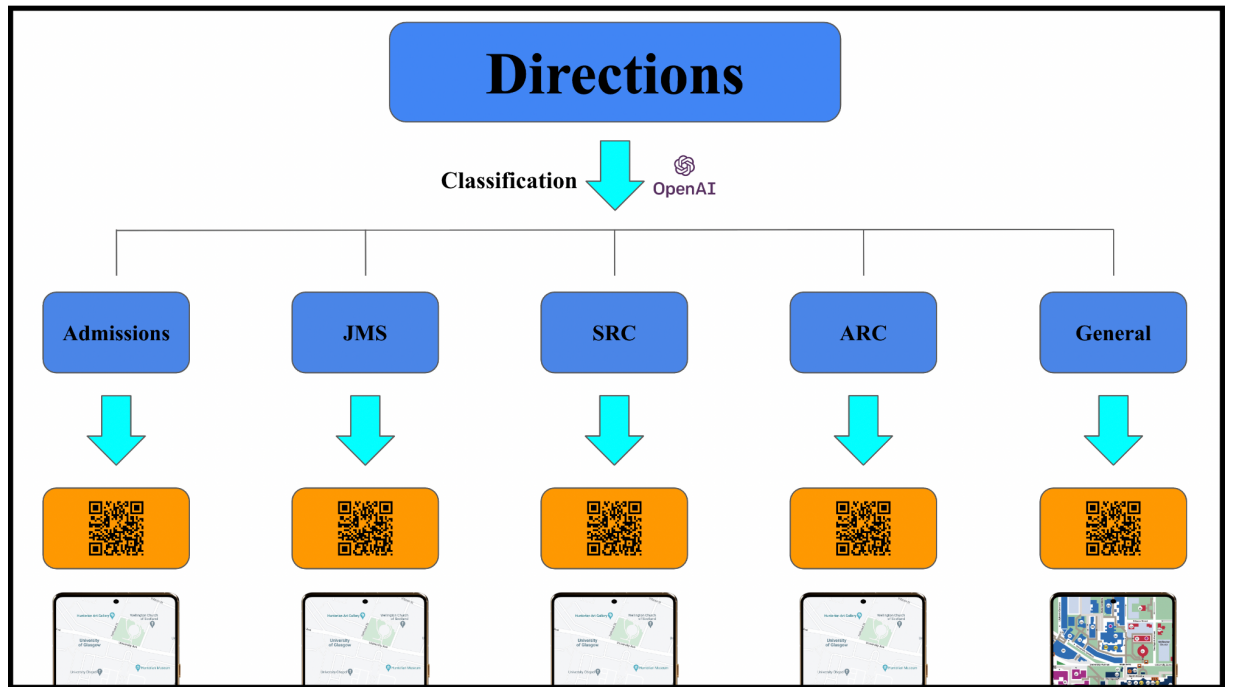


Figure 4.3: The dialogue state machine (campus directions)

translated into Mandarin and Modern Standard Arabic by native speakers. Interactions were intentionally kept short due to the technical nature of the content, and each session concluded with a QR code linking to the corresponding HTML page (Fig. 4.3). OpenAI was used exclusively for intent classification and the optional chitchat feature.

#### 4.1.4 Studies Overview

We evaluated the multilingual support robot through two complementary approaches: (1) a controlled lab study and (2) an in-the-wild deployment at a UK university.

##### Study 1: Student Lab Study

Conducted during summer 2024, this controlled lab study involved 60 international students. Each participant used the robot to complete four tasks related to *campus directions*, *local tax exemption*, *financial aid*, and *official documents*. They interacted with the robot both in English and in their native language (Mandarin Chinese or Modern Standard Arabic). After completing the tasks, participants evaluated the system’s usability and effectiveness. The study aimed to examine user performance in each language and explore preferences when participants were given a choice between English and their native language.



Figure 4.4: The student services center in the university

### **Study 2: Student In-The-Wild Study**

To complement the lab findings and assess real-world performance, we deployed the same robot in the University of Glasgow’s student support center during the opening weeks of the 2024/25 and 2025/26 academic years. The robot provided information on the same four topics. Across both phases, 124 students interacted with the system and completed an evaluation, allowing us to examine its utility in authentic, high-traffic environments.

## **4.2 Stakeholder Consultations**

The development of the university support robot involved extensive consultations with the student support team to ensure that the robot meets the needs of all the parties involved. This process included observing support officers while they were interacting with international students on several occasions and also held meetings with the managers of the student support center (Fig. 4.4), in regards to usefulness and data safety. The researcher also spent time alongside support officers to identify common topics raised by students, which informed the selection of the four tasks: *campus directions*, *local tax exemption*, *financial aid*, and *official documents*.

## 4.3 Student Lab Study

### 4.3.1 Overview

This section evaluates the performance of the multilingual student support robot through a controlled lab study with 60 international students. Participants were asked to complete four pre-defined tasks with the robot: *campus directions*, *local tax exemption*, *financial aid*, and *official documents* (Figure 4.5). Each interaction involved both English and the participant’s native language (Mandarin Chinese or Modern Standard Arabic). The study aimed to examine user performance in each language and explore preferences when participants were given a choice between English and their native language.

### Hypotheses

Based on previous literature on second-language interaction described in Section 2.1, we had the following hypotheses for this study:

- H1.1** Students will choose to perform the tasks in their native language more often than in English.
- H1.2** Students choosing to use the robot in their native language will perform better than when using it in English.
- H1.3** Students choosing to use the robot in their native language will rate the interactions more positively than when using it in English.
- H1.4** Students using the multilingual robot will report low cognitive demands.
- H1.5** Students using the multilingual robot will report high habitability.
- H1.6** Students using the multilingual robot will report high likeability.

### Participants

60 international students currently studying in the University of Glasgow were recruited through the university’s participant pool, word-of-mouth, and posters. Native Language was represented by 43 native speakers of Mandarin Chinese (hereafter ‘Mandarin’) and 17 native speakers of Modern Standard Arabic (hereafter ‘Arabic’). Ages ranged from 21 to 35 for Mandarin (67.4% women, mean age = 24.67,  $SD = 3.27$ ) and 22 to 41 for Arabic (82.4% women; mean age = 32.94,  $SD = 4.98$ ). Additional demographic details are provided in Table B.1. All participants were compensated for their participation with a £5 shopping voucher.

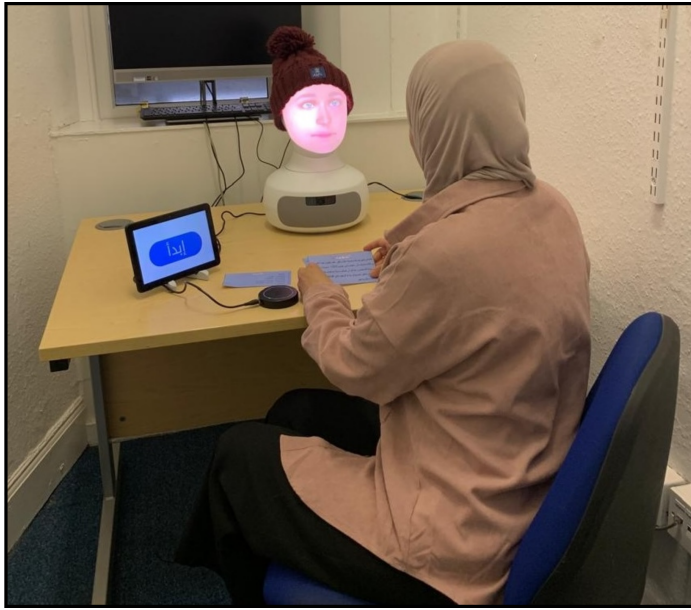


Figure 4.5: A participant interacting with the robot in the lab

### Procedure

The study was conducted in a quiet university lab under controlled conditions. Participants were first introduced to the robot and given instructions on how to interact with it. They then completed four information-seeking tasks in the order shown in Fig. 4.6. Each task was presented on a card specifying the details and the language to be used. For example, task 4 (Fig. 4.7) required students to ask the robot about printing an official letter from the university, and Fig. 4.8 illustrates a sample interaction for this task. The complete set of task cards, provided in three languages, is included in the appendix (Fig. B.1).

Participants were randomly assigned to two conditions (Fig. 4.6). In Condition 1, they completed the first task in their native language (Arabic or Mandarin) and the second in English; in Condition 2, the order was reversed. In both conditions, participants were free to choose their preferred language for the third and fourth tasks.

We gathered objective and subjective dependent measures from the participants. For objective measures, we recorded the language chosen (Language Choice) for Tasks 3 and 4 (note that the language for Tasks 1 and 2 was determined by the condition). We also measured the performance on each task (Task Performance) by noting whether the user received a QR code corresponding to the task they were supposed to complete. A failure was recorded if the conversation ended prematurely or a wrong QR code was given.

We also recorded three subjective measures, as described in Section 3.3. After each support interaction, participants provided emoji-based task feedback. Once all four tasks were completed, they filled out a survey using a subset of the SASSI questionnaire, and finally answered a single-item question on perceived helpfulness.

Finally, in the post-experiment questionnaire, participants were asked to explain why they

chose the language they used for Tasks 3 and 4. These open-ended responses provided qualitative insights into their decision-making and were analyzed in the next subsection.

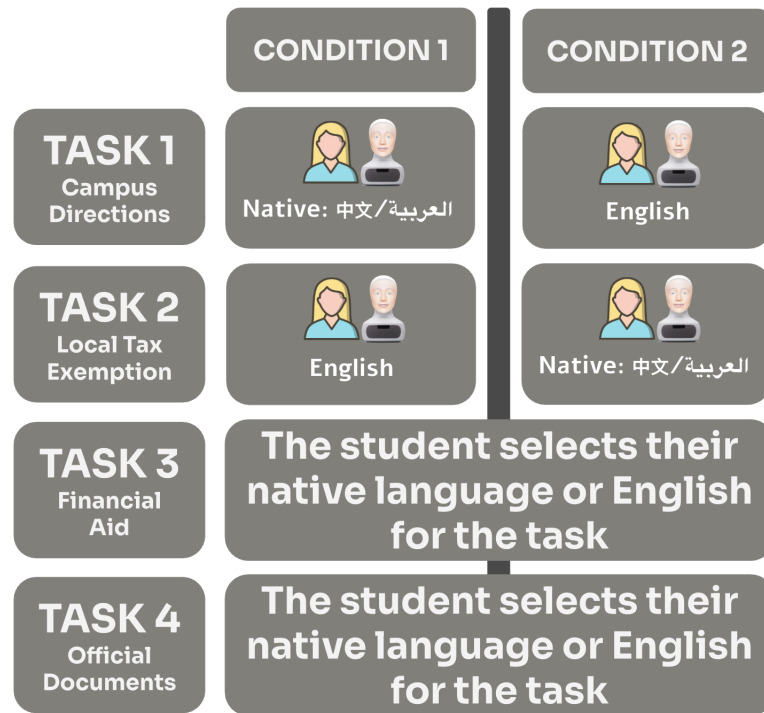


Figure 4.6: Tasks, Conditions, and Language Choice in the Lab Study

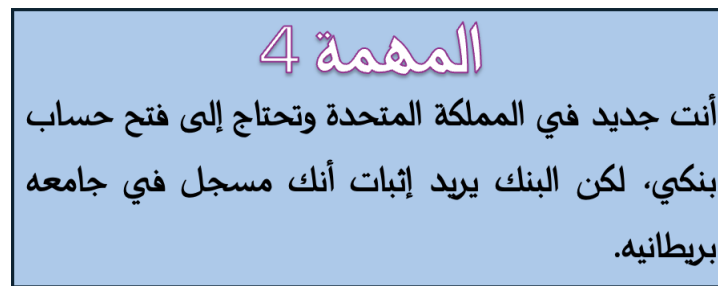


Figure 4.7: Task 4 in Arabic. Translation: *You're new to the UK, and you need to open a bank account, but the bank wants proof that you're enrolled in a UK university.*

## 4.3.2 Qualitative Results

### Language Choice and Rationale Across Tasks

This subsection presents participants' rationales for language choice in Tasks 3 and 4, based on open-ended responses collected in the post-experiment questionnaire. Two-thirds of participants chose to complete both tasks in their native language, including 72% of Mandarin speakers and

STUDENT: [The user clicks on "English" on the tablet]  
 SYSTEM: *Hi, I'm a student support robot. You can ask me about campus directions, official documents, local tax exemption and financial aid. How can I help you today?*  
 STUDENT: *uh hi um I'm just wanted to uh open a bank account*  
 SYSTEM: *Which official document do you need?  
 Certify letter or bank letter?*  
 STUDENT: *yes a bank letter*  
 SYSTEM: *For information concerning the bank letter, please scan the QR Code below. [after 5 seconds]  
 Have you scanned the QR code?*  
 STUDENT: *uh yes*  
 SYSTEM: *Can I help you with anything else?*  
 STUDENT: *uh no thank you thank you so much*  
 SYSTEM: *I would appreciate it if you'd rate our conversation by clicking on the tablet. Thank you and have a lovely day.*  
 STUDENT: [The user clicks on a happy emoji on the tablet]

Figure 4.8: Example interaction with the robot for Task 4 (Participant 18).

50% of Arabic speakers. This pattern underscores the centrality of linguistic comfort and clarity when interacting with the multilingual support robot.

### Task 3: Reasons for Choosing the Native Language

Participants most commonly cited *ease and confidence* as reasons for selecting their native language:

*"Mandarin makes me feel more confident and it's easier for me to get information."*

*"It is easier to use my first language and to have a better understanding of the information resulting in a successful conversation."*

They also emphasized *clarity and accuracy* in expressing needs:

*"I describe my question in Mandarin more accurately."*

*"It is a little bit hard for me to express in English."*

A further set of responses reflected *curiosity and testing* the robot's capabilities:

*"I wanted to hear the robot's response in Arabic."*

*"I want to check how it can perform in Mandarin."*

Finally, some participants noted *continuity and familiarity*:

*"I wanted to continue using the robot in Arabic, because this is the first time I talk to an Arabic robot."*

*"More familiar."*

**Task 4: Similar Patterns with Added Complexity**

For Task 4, similar patterns emerged, with participants again emphasizing ease and familiarity:

*“Same reason as Task 3.”*

*“It is easier to ask for help using my first language.”*

*“I am more familiar with the language.”*

However, some responses highlighted *accuracy for complex topics*, such as financial or banking procedures:

*“I can tell the robot what kind of certificates I need more exactly.”*

*“I do not know much about bank documents in English.”*

Curiosity persisted in Task 4 as well:

*“I wanted to hear the robot’s response in Arabic just to check if it can understand me or not.”*

*“To hear how the robot would respond to my accent.”*

**Cross-Task Language Switching: English in Task 3, Native in Task 4 (n=2)**

A small subgroup (one Arabic speaker and one Mandarin speaker, both women) chose English for Task 3 and their native language for Task 4. Their reasons for choosing English in Task 3 included general preference and topic fit:

*“It was just more preferable.”*

*“I guess that situation is more possible for English speakers.”*

When moving to Task 4, the same participants switched to their native language to gain *expressive comfort* and *precision*, particularly for sensitive or personally salient content:

*“For me it was easier to express it in my language.”*

*“Many classmates from China have problems with bank letters; that task situation is very helpful.”*

Although only two participants exhibited this pattern, their responses suggest that topic sensitivity and the need for nuanced expression could play a role in language switching.

**Cross-Task Language Switching: Native in Task 3, English in Task 4 (n=18)**

A larger subgroup (seven Arabic speakers and eleven Mandarin speakers) completed Task 3 in their native language but chose English for Task 4. When explaining their choice for Task 3, participants highlighted similar themes to those seen in the overall sample, such as *fluency*, *clarity*, and *testing/curiosity*:

*“The scenario would be better to use Mandarin.”*

*“I use Mandarin more fluently than English.”*

*“I want to test the ability of the robot to identify Mandarin.”*

*“I am not very familiar with that question in English, so I chose Mandarin.”*

*“I feel a little bit embarrassed to talk about my financial situation in English.”*

*“Sometimes sponsors ask me to provide letters with their names in Arabic and I’m not sure how to translate properly.”*

*“I thought it might be better to test if I am a fresh student and speaking local, not standard Arabic.”*

*“I wanted to check if the robot really gets what I say.”*

For Task 4, these participants switched to English for reasons related to *domain appropriateness*, *real-world transfer*, and *system performance*:

*“It is basic English; I can express it smoothly.”*

*“I know how to ask this question in English, and I will use English with a real person at the bank.”*

*“This task is more suitable to express in English, especially words like ‘register’ or ‘bank letter’.”*

*“I wanted to compare the two languages.”*

*“It was much easier for the robot to understand [in English].”*

*“I was interested in whether the robot can recognize Chinese-accented English well.”*

*“It refers to the bank account in England. English is more suitable.”*

Here, participants explicitly linked English use to preparing for authentic interactions (e.g., visiting the bank), leveraging familiar terminology, and the perception that the robot would respond more reliably in English for this topic.

### **Synthesis and Implications**

Across both tasks, participants’ rationales clustered around *comfort and confidence*, *clarity and accuracy*, and *curiosity/testing* the system, with an additional *topic fit/real-world transfer* theme shaping cross-task switches. The mixed-choice subgroups show that language preference is *task-dependent*: participants strategically switch languages based on the sensitivity of the topic, the specificity of required terminology, expectations about real-world usage, and perceived recognition quality. These findings support the hypothesis that users prefer their native language overall, while also highlighting flexible, context-driven switching that strengthens the case for designs that (i) allow on-the-fly language changes, (ii) surface bilingual terminology for bureaucratic concepts (e.g., “bank letter”, “register”), (iii) address dialectal variation, and (iv) provide reassurance and privacy for sensitive disclosures.

### 4.3.3 Quantitative Results

We present descriptive results for the categorical data, which show clear patterning, supported by a series of Chi-square tests for language choice, task performance and task feedback, and independent t-tests for the SASSI scores. To control for multiple comparisons, we applied the Bonferroni correction, adjusting the significance threshold for all tests to  $\alpha = 0.0056$ .

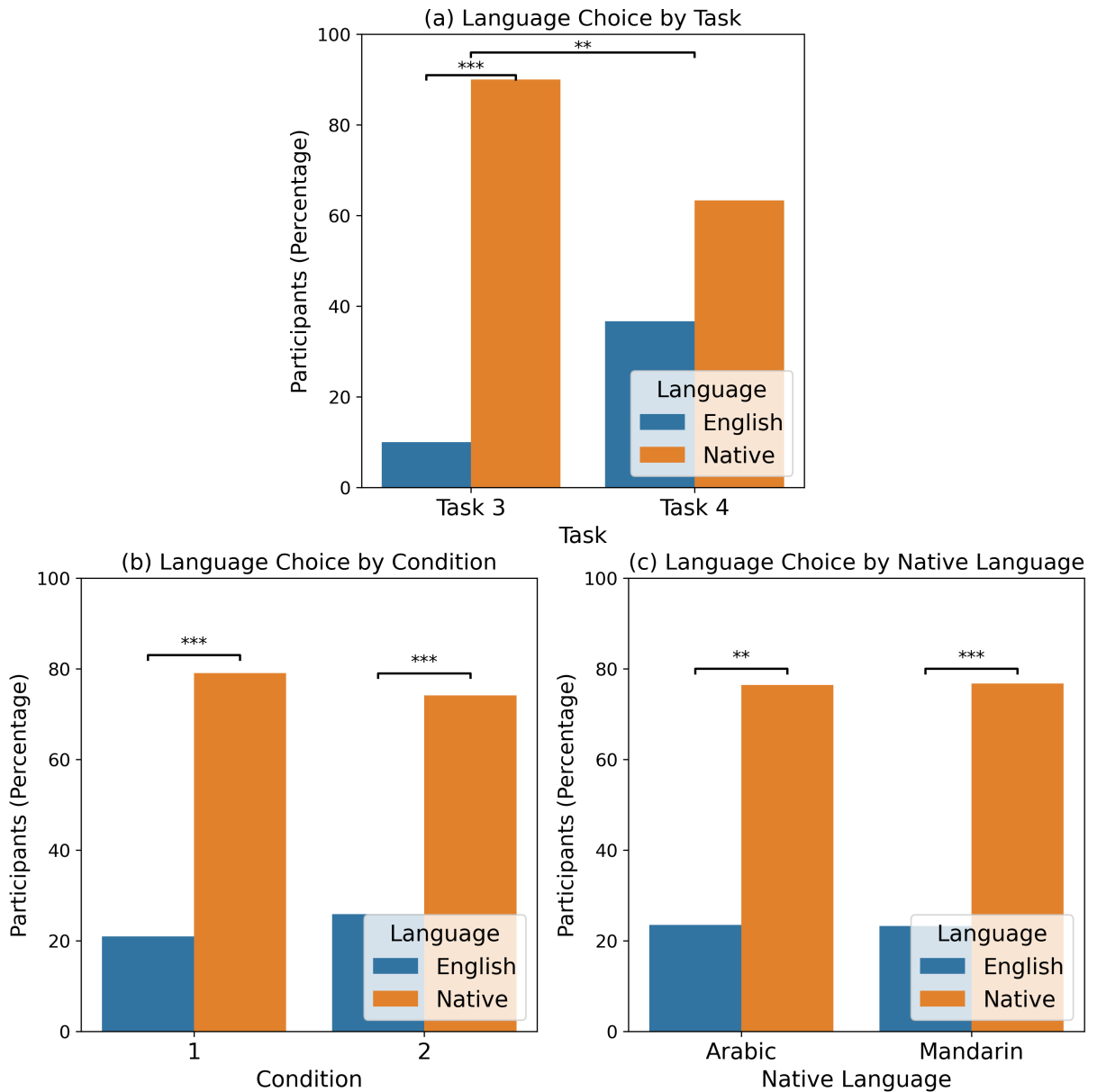


Figure 4.9: Language Choice by Task, Condition, and Native Language ( $\alpha = .0056$ )

#### Language Choice

After applying the Bonferroni correction, only 6/9 comparisons remained statistically significant ( $p < .0056$ ). Most participants preferred to use their native language over English con-

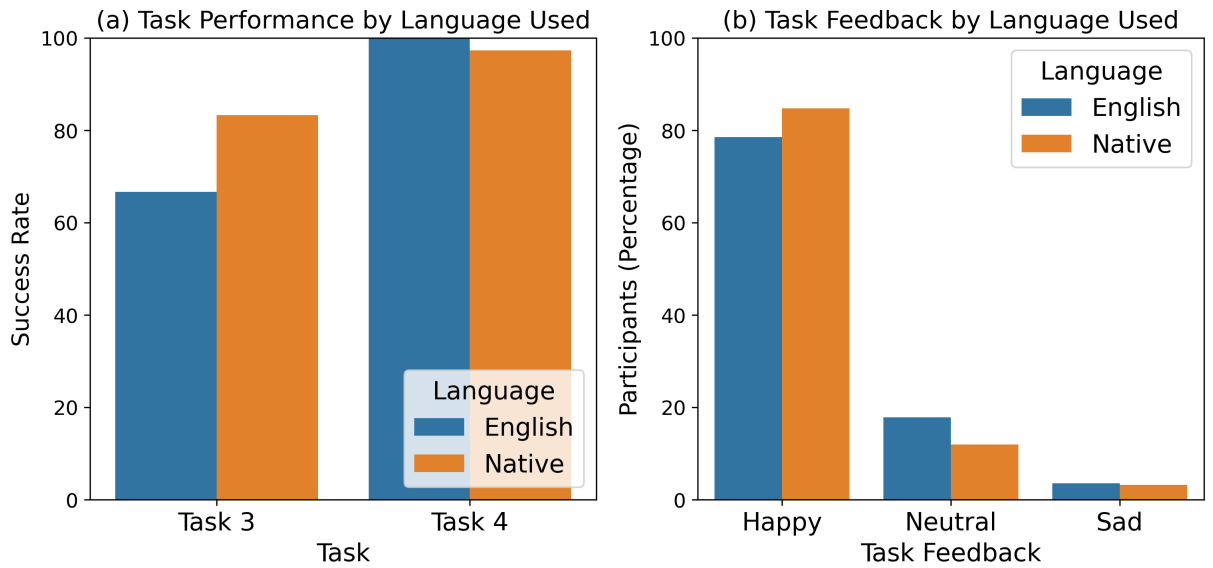


Figure 4.10: Task Feedback and Task Performance by Language Used

firming H1.1 (Figure 4.9): a) Task: English vs. Native in Task 3 ( $\chi^2(1) = 38.4, p < .001$ ); b) Condition: English vs. Native in Condition 1 ( $\chi^2(1) = 20.9, p < .001$ ) and in Condition 2 ( $\chi^2(1) = 13.52, p < 0.001$ ); c) Native Language Background: English vs. Native in Arabic ( $\chi^2(1) = 9.53, p < .0056$ ) and in Mandarin background ( $\chi^2(1) = 24.6, p < .001$ ). Language Choice also varied by Task, as Task 4, a relatively simple task relating to official documents, had more participants choosing to use English than in Task 3, though participants' native language was still preferred. Choosing to use their native language was not related to experimental Condition (Figure 4.9(b)), or native language of the participant (Figure 4.9(c)).

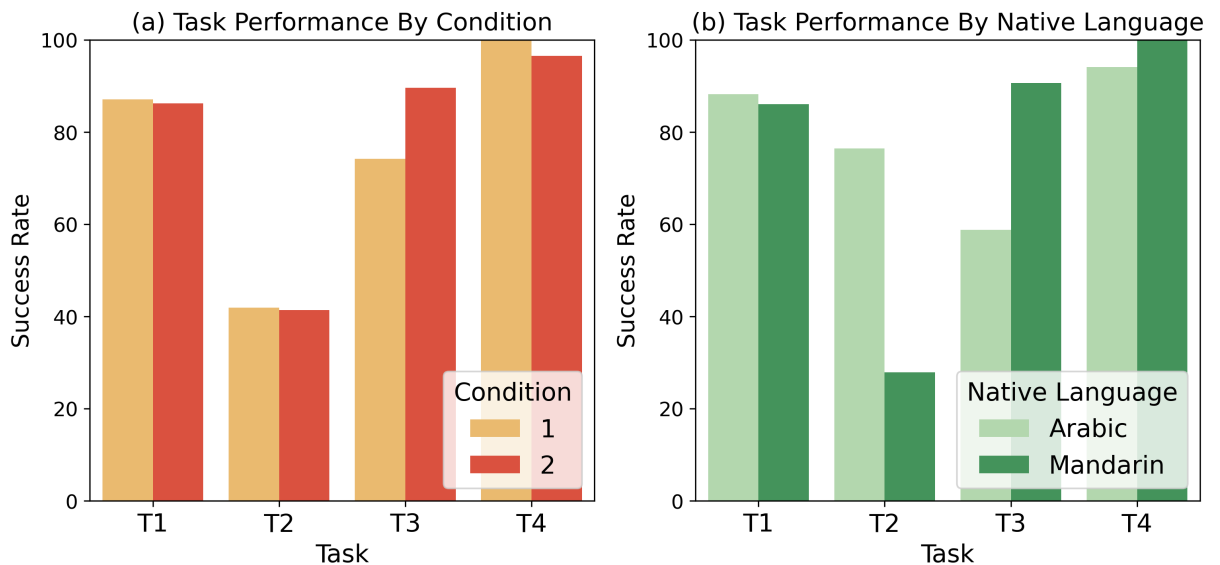


Figure 4.11: Task Performance by Condition and Native Language

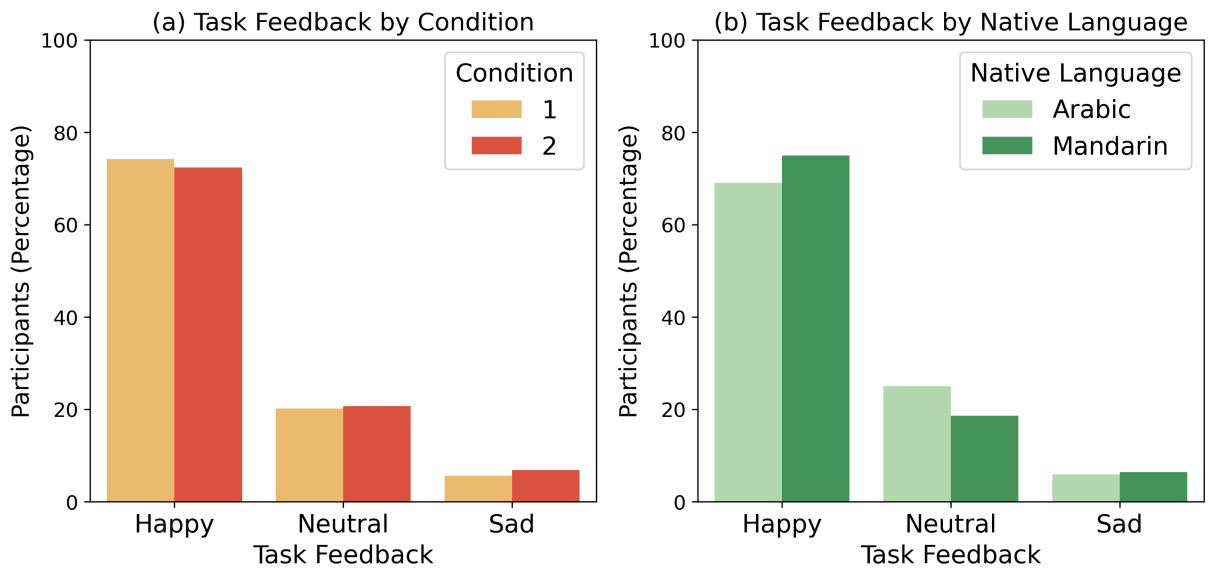


Figure 4.12: Task Feedback by Condition and Native Language

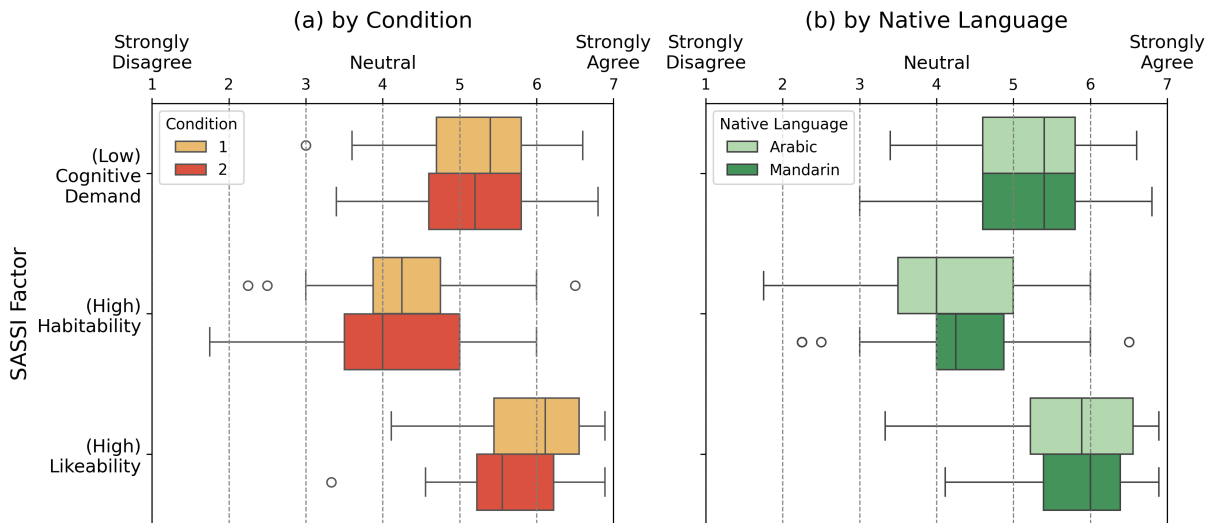


Figure 4.13: SASSI Factor Scores by Condition and Native Language

### Task Performance

Contrary to H1.2, there was no significant difference when carrying out tasks in different languages (Figure 4.10(a)). Figure 4.11(a) shows that Task 2, obtaining information about local tax exemption was done least successfully, but this is largely because the Mandarin-speaking participants found it particularly difficult (Figure 4.11(b)) – this was potentially a less familiar concept for these participants. At the same time, the Arabic speakers did not complete Task 3 as well as the Mandarin speakers, showing that task performance is at least partly contingent on students’ native language.

### **Task Feedback**

Immediate feedback via the Happy/Neutral/Sad emoji responses showed that most participants were happy with the interactions, irrespective of Language Choice, i.e. whether they had chosen their native language to carry out Tasks 3 and/or 4 (Figure 4.10(b)), contra our expectations (H1.3). We also found that Task Feedback was not affected by experimental Condition (Figure 4.12(a)), or appreciably by students' native language, as a vast majority of students from both language backgrounds responded Happy after each task was performed (Figure 4.12(b)).

### **SASSI Results**

Figure 4.14(a) shows that in general, the Cognitive Demand of the multilingual system was perceived to be relatively light (7 = lowest/1 highest), average is (5.14), its Habitability was above average (4.23), and its Likeability was generally high (5.81). These responses did not vary significantly by Condition, or by students' Native Language (Figure 4.14(b)), and so overall confirmed our expectations for H1.4 and H1.6, and partly for H1.5.

However, looking more closely, we found a difference in responses according to Native Language by Condition, namely whether the student had to start in their native language (Condition 1) or in English (Condition 2). Figure 4.14 shows that Arabic speakers reported significantly higher Habitability responses in Condition 1 than in Condition 2 ( $t(15) = 2.15, p = .048, d = 1.04$ ), and also show a trend to higher Likeability responses for Condition 1. The Mandarin speakers did not show any significant differences by Condition, though their trend for Habitability is in the opposite direction, finding the system more tractable in Condition 1. These differential responses by native language according to Condition partly account for the lower average rating for Habitability found overall.

### **Robot Helpfulness**

Responses to the single-item question on perceived helpfulness indicated that all participants considered the robot helpful or somewhat helpful ("Maybe"), regardless of native language background. This finding aligns with our expectations for H1.4, H1.5, and H1.6 (Figure 4.15).

## **4.3.4 Discussion & Conclusions**

Overall, most of our hypotheses were confirmed for the lab study: the students did indeed choose their own language over English when given the option (H1.1), although there wasn't any significant difference in their performance when completing tasks in their own language (H1.2). The emoji responses did not show the expected pattern (H1.3), with all participants rating the robot equally highly regardless of the language and condition—this is likely to be due to a combination of the novelty effect and the social desirability bias [168], but is a welcome confirmation

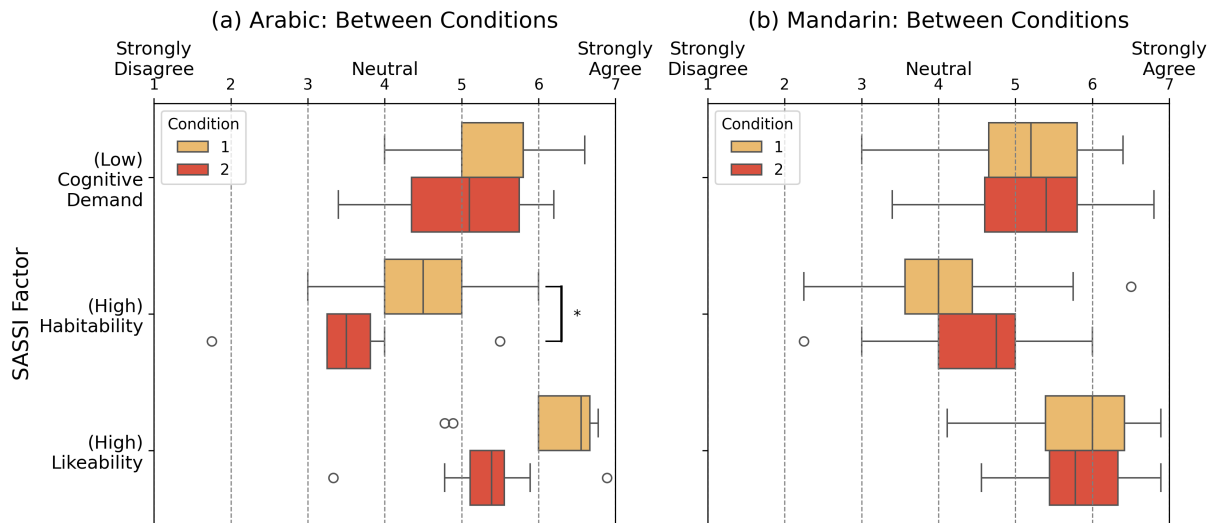


Figure 4.14: SASSI Factor Scores by Condition within each Native Language

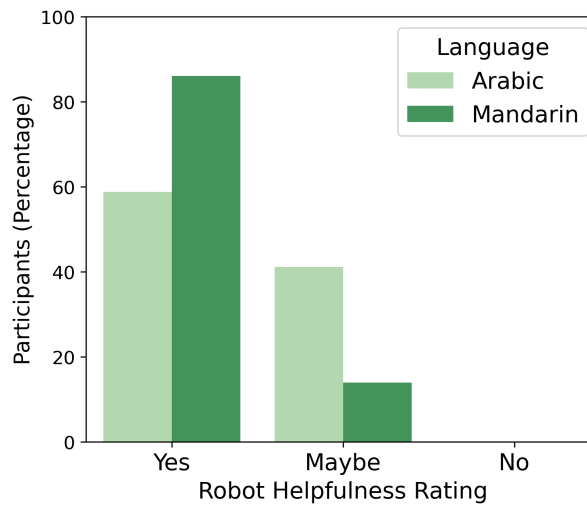


Figure 4.15: Robot Helpfulness by Native Language

that the robot was generally liked. The SASSI results confirmed our remaining hypotheses regarding cognitive demand (H1.4), habitability (H1.5), and likeability (H1.6), although here the results were more nuanced and varied depending on the participant’s native language: in particular, the Mandarin speakers seem to find the system easier to use when they started with their native language, while the Arabic speakers found it easier when they started with English first. It is not clear why this might have occurred, and further investigation with groups from other language backgrounds is definitely warranted.

Our lab study had several limitations. A key limitation is the absence of a ground truth or baseline comparison condition. Participants interacted only with the robot, without completing equivalent tasks using alternative interfaces such as a web-based system or a conversational agent. As a result, responses to the single-item question on perceived helpfulness, such as “helpful” or “somewhat helpful”, should be interpreted as subjective perceptions rather than

indicators of performance relative to other solutions. In particular, responses such as “somewhat helpful” may reflect partial task success, uncertainty, or limited interaction depth rather than strong endorsement of the system.

This limitation is consistent with broader challenges in the literature. Prior work on embodied interaction has shown mixed evidence regarding whether physically embodied agents outperform voice-based or screen-based interfaces, with some studies reporting stronger user engagement [96] and others finding no significant differences [97, 98]. As such, without a comparative condition, it is not possible to determine whether the robot provides measurable advantages over existing support systems.

The study had other limitations, as we did not assess participants’ English proficiency or how long they had lived in the UK - both of which may have influenced their language choice for the tasks. In addition, our evaluation metrics could have measured more parameters, and explored more aspects concerning the robot’s perceived usefulness.

In conclusion, we have evaluated a multilingual student support robot through a controlled lab-based study. International student participants chose to interact with the robot in their native language, gave positive feedback about the multilingual robot, and also often performed better when given the chance to use their own language.

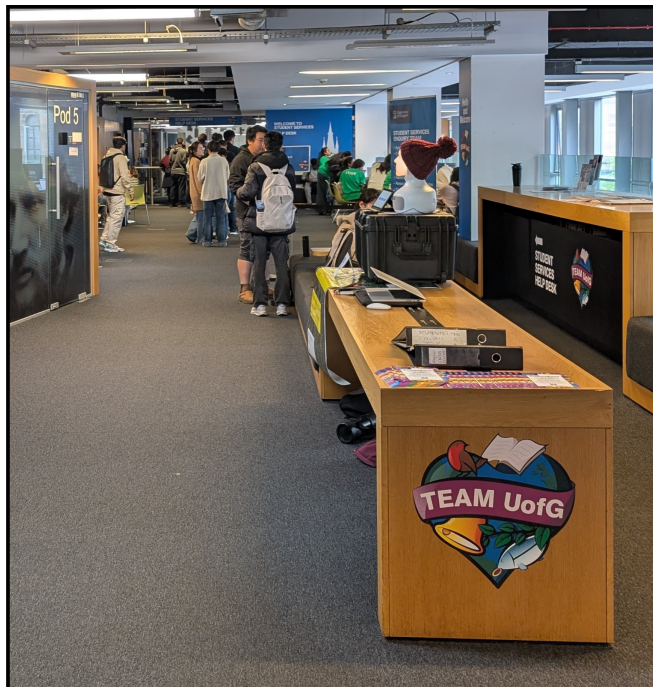


Figure 4.16: Furhat in the student support center

## 4.4 Student In-The-Wild Study

### 4.4.1 Overview

This section evaluates the performance of the multilingual student support robot through an in-the-wild study with 124 university students. To reinforce the findings from the lab study addressing **RQ3a**, we conducted a two-phase field deployment of the same robot (Fig. 4.16), programmed to provide information on four topics, in the university's student support center during the opening weeks of the 2024/25 and 2025/26 academic years.

### Hypotheses

We had the following hypotheses for this study:

- H2.1** Students using the robot in their native language will rate the interactions as Happy/Neutral more than Sad.
- H2.2** Students using the multilingual robot will report low cognitive demands, in general.
- H2.3** Students using the multilingual robot will report high habitability, in general.
- H2.4** Students using the multilingual robot will report high likeability, in general.

### Participants

A total of 124 students interacted with the robot and provided immediate Happy/Neutral/Sad feedback; 32 of them also completed the SASSI questionnaire. Respondents were 50% women and 25% self-described, with ages ranging from 18 to 40 (mean age = 23.75,  $SD = 4.23$ ). Native languages included English (15), Mandarin (13), Arabic (1), and other languages (3). Additional demographic details are provided in Table B.2. Both Task Feedback and SASSI responses echoed lab results. Note that one student whose native language is Mandarin chose to have their interaction in English.

Both Task Feedback and SASSI responses echoed lab results. Students who used the system responded positively, describing it as helpful and easy to use. Staff involved in the pilot also shared encouraging feedback.

## Procedure

The robot was positioned near the entrance of the student support center to ensure visibility without obstructing visitors seeking assistance from staff. Deployment occurred in two phases: in 2024, the robot was active for five days across two weeks, with sessions lasting 90 minutes each; in 2025, the Furhat robot was deployed for three consecutive days, with daily sessions of 2.5 hours. Students were free to interact with the robot at any time during these sessions. Figure 4.16 shows the robot during the real-world deployment.

Students were invited to engage with the robot either upon entering or leaving the center. They could choose any of four supported tasks: campus directions, local tax exemption, financial aid, or official documents. Each participant selected their preferred language for interaction. At the end of the session, participants were asked to provide immediate feedback via the tablet interface and were invited to give informed consent to complete a longer online questionnaire.

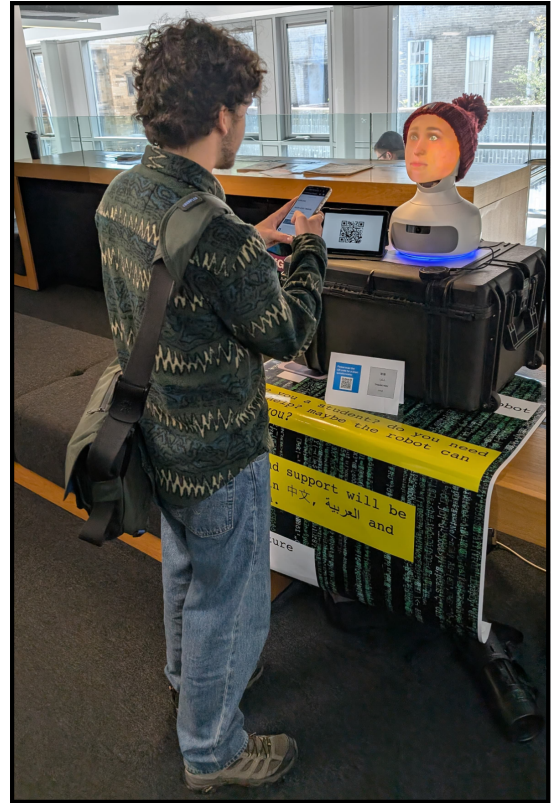


Figure 4.17: A student interacting with Furhat and scanning a QR code

### 4.4.2 Qualitative Results

Across two deployment phases in the student support center, we observed a mix of curiosity and hesitation among students. The robot's presence attracted attention, yet not all students were eager to engage. One student walked past and muttered audibly, "I don't think the robot can help me", reflecting initial skepticism. However, once a student began interacting with the robot, others often followed, particularly when the conversation occurred in their native language. Language emerged as a strong catalyst for engagement: Arabic-speaking staff facilitated some interactions, and Chinese students showed interest when the robot responded in Mandarin. Nevertheless, speech recognition challenges were evident in one early interaction with an Egyptian Arabic speaker, where the student thought the robot struggled to understand their accent, though a subsequent attempt was successful.

Beyond linguistic factors, emotional responses varied widely. A Chinese student appeared not at ease during an initial encounter, while another later praised the robot, saying "you did a great job!". In contrast, one student described the robot as "too creepy", echoing concerns re-

lated to the uncanny valley and broader anxieties about AI technologies such as ChatGPT. Some students preferred to observe rather than participate, and a few left mid-interaction to speak directly with the researcher who stood nearby, suggesting uncertainty about how to engage. These behaviors align with findings from a recent study using a Furhat robot in a public space [169]. Others struggled to identify what questions to ask, indicating a need for clearer guidance on the robot’s capabilities.

Despite these mixed reactions, the robot demonstrated practical utility. It assisted students with the common tasks for which it was programmed, such as *local tax exemption* queries and printing *bank letters*, demonstrating practical utility beyond initial novelty. However, students did not always understand that they needed to respond to the robot’s prompts, and some expressed discomfort when invited to “have a short chat” with the robot, admitting reluctance toward robots. When explicitly asked whether this discomfort was due to disliking robots, one student replied, “a little bit”.

Staff perspectives were similarly nuanced. While staff generally encouraged students to use the robot, one staff member gave a sad emoji feedback at the end of an interaction, jokingly saying they don’t want to be replaced by robots.

Overall, these observations show that while the robot attracted attention and provided useful support for common tasks, engagement was shaped by language accessibility, emotional comfort, and clarity of purpose. Mixed reactions, from curiosity to discomfort, suggest that practical benefits alone do not guarantee acceptance in student services.

### 4.4.3 Quantitative Results

We employed similar measures to those used in the lab-based study, adapted for the real-world setting. Here, we report the subjective measures: (1) immediate emoji-based task feedback for all participants, (2) responses to the SASSI questionnaire for those who completed the online survey, and (3) answers to the single-item question on perceived helpfulness, consistent with the lab study.

#### Task feedback

We compared task feedback across two phases of the field deployment. In 2024, there were 49 interactions, while in 2025, we collected 75 responses. As shown in Fig. 4.12(a), the overall pattern remained consistent across both phases.

We also contrasted the field study with the lab setting, which included 240 responses (60 participants x 4 tasks) compared to 124 responses from the field. Immediate feedback, captured via Happy/Neutral/Sad emoji responses, indicated that most participants in the field study (80%) were happy with their interaction with the multilingual system (Fig. 4.18(b)). This outcome aligns with our hypothesis (H2.1) and mirrors the pattern observed in the lab study.

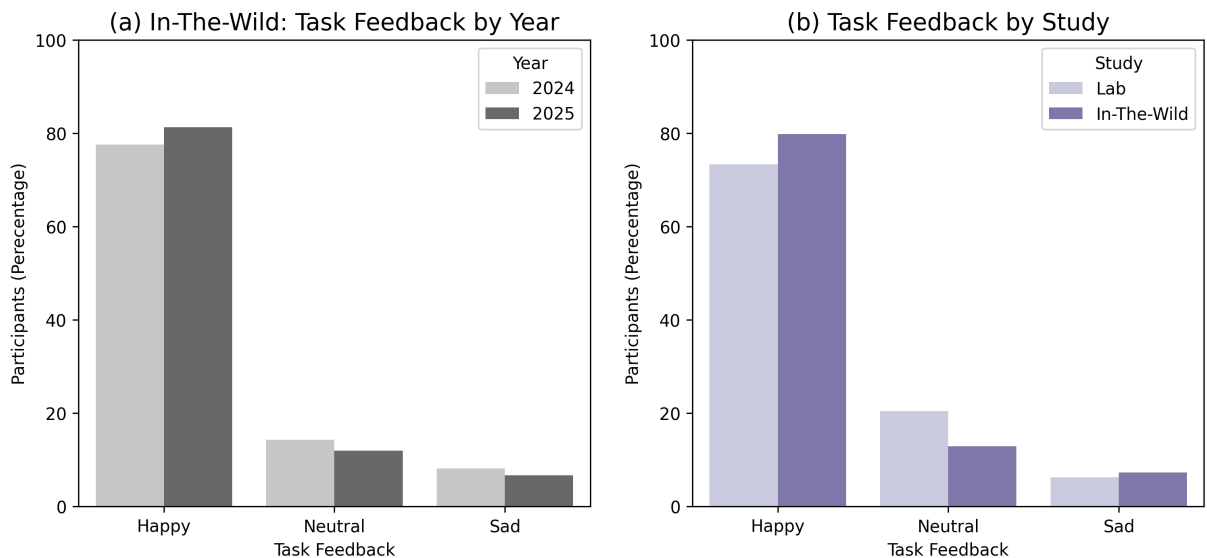


Figure 4.18: Task Feedback Between Studies and Deployment Year

### SASSI results

Overall, responses to the SASSI questionnaire were consistent with our expectations (Fig. 4.19(a)). Participants in the field study perceived the system’s Cognitive Demand to be relatively light (mean = 4.92 on a 7-point scale, where 7 indicates lowest demand), Habitability as average (mean = 4.29), and Likeability as generally high (mean = 5.27). These findings strongly support our hypotheses on habitability (H2.3) and likeability (H2.4), and provide partial support for cognitive demand (H2.2).

However, the small sample size (English:  $n = 13$ ; Mandarin:  $n = 15$ ) limits interpretation of differences by language. When comparing Mandarin speakers across studies (Fig. 4.19(b)), no significant differences emerged. The same pattern held when considering all respondents regardless of native language (Fig. 4.19(c)).

### Robot Helpfulness

Consistent with the lab-based findings, responses to the single-item question on perceived helpfulness indicated that the vast majority of participants considered the robot helpful or at least somewhat helpful (“Maybe”), regardless of native language background. This result reinforces our expectations regarding H2.2, H2.3, and H2.4 (Figure 4.15).

## 4.4.4 Stakeholder Interviews

We interviewed support officers and managers before and after the deployment in the university’s student support center during the opening weeks of the 2024/25, in order to explore their perspectives. We also asked them rate on a 7 point Likert scale “*How comfortable are you with*

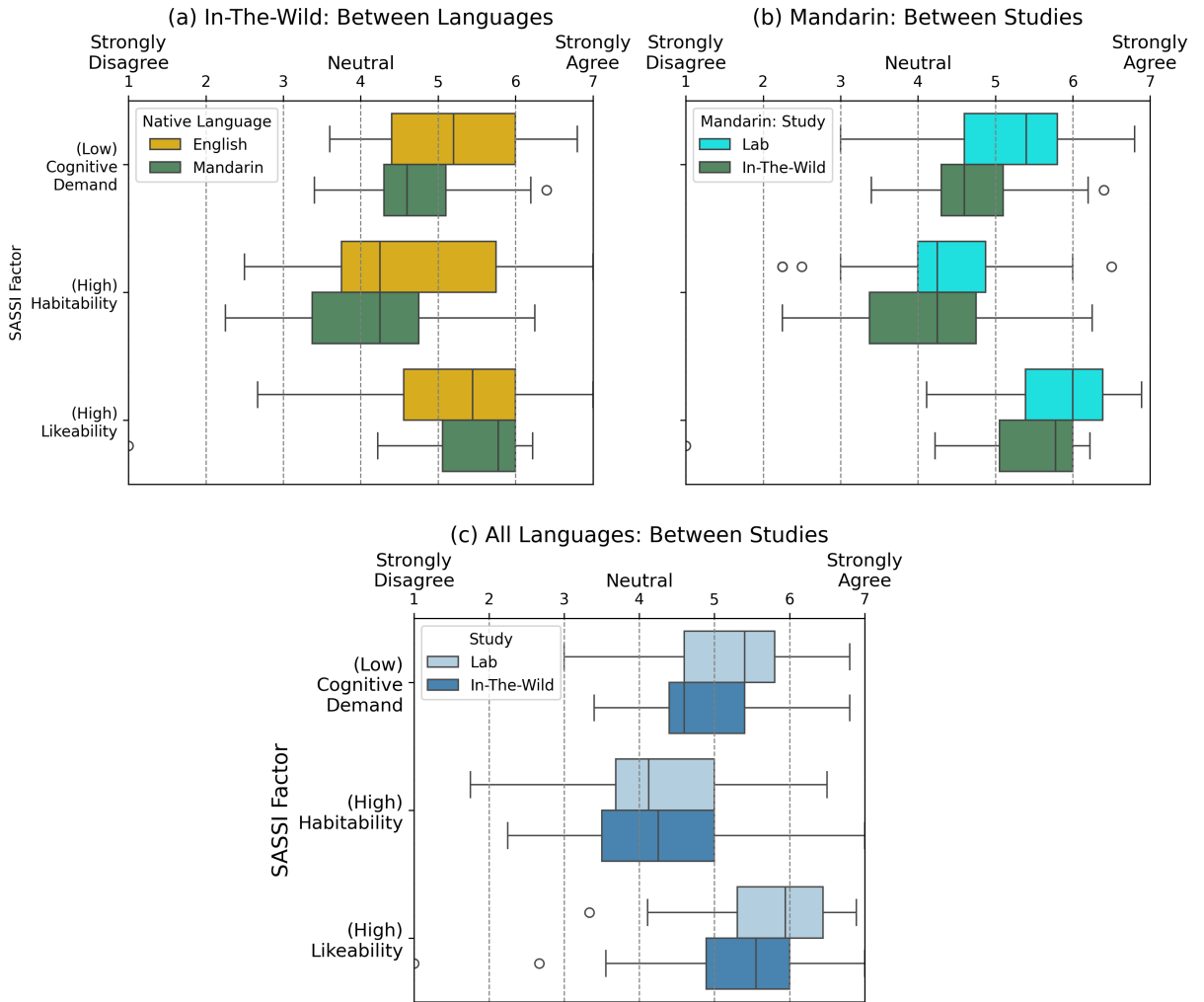


Figure 4.19: SASSI Factor Scores by Native Language and Study

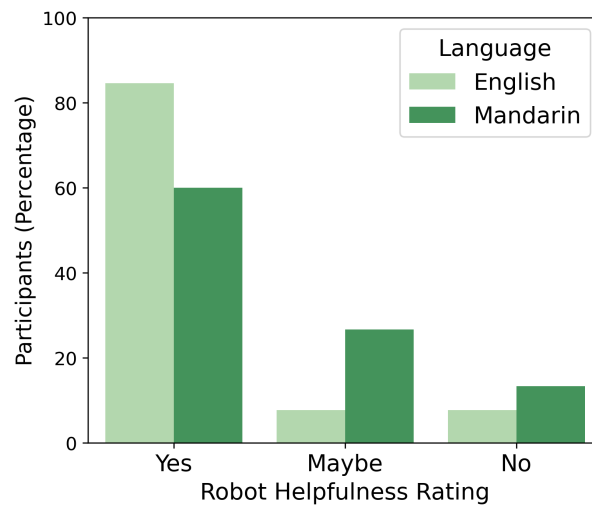


Figure 4.20: Robot Helpfulness by Native Language

*the idea of collaborating with a robot?*". For a full description of the interview questions, see Figures B.2–B.3. We found that the overall opinion of the interviewees rose during the deployment process, positively answering **RQ2a**.

### **Before Deployment**

We interviewed three support officers and a manager about having a robot in their workplace. One support officer was very suspicious, asking how she would know what the robot is saying if it speaks in Mandarin or Arabic. Another officer said she doesn't like robots and AI: *automation takes away people's jobs*. The manager was very supportive of the idea, and said she was curious about how people would interact with it. All participants agreed that it *will help the students that won't have to wait 20 minutes to ask a simple question* and had the potential to free the team for other tasks.

### **After Deployment**

During the deployment, support officers and managers frequently approached the research team to ask questions and share their impressions. Overall, they expressed curiosity and were pleased to see students interacting with the robot in multiple languages.

Follow-up interviews were conducted with two managers and one support officer, two of whom had also participated in pre-deployment interviews. Both managers agreed that a robot could be a valuable addition to the workplace if it provides clear benefits, particularly for transactional information exchange. They also noted that the robot could enable extended service hours by offering different levels of support at various times of the day.

One manager highlighted a growing challenge: declining English proficiency among international students, which complicates support, especially when parents, who often speak no English, require assistance. The support officer was optimistic about the robot's potential to ease pressure during peak periods. She suggested that the robot could assist new arrivals with routine tasks, such as opening a bank account, freeing staff to focus on more complex issues. However, she raised an important question: *What would an international student choose when faced with both a robot and a support officer?* To address language barriers, she shared that she currently keeps a personal list of useful phrases translated into Chinese, such as "cleaning the cache" and "pop-up windows."

All three interviewees reported feeling comfortable with the robot's presence. They mentioned using AI tools like ChatGPT and speculated that interacting with a physical robot might be easier for students than searching online. A concern was raised about cost-cutting, with fears that the university might prefer robots over human employees. Managers acknowledged that robots cannot replace staff but noted that their reliability (never sick or late) could make them attractive for certain roles. Overall, participants indicated that their opinions remained positive or improved after observing the robot in action.

### 4.4.5 Discussion & Conclusions

Observations from the two deployment phases revealed that students' reactions to the robot were shaped by curiosity, language accessibility, and emotional comfort. While the robot attracted attention, some students were initially skeptical – one remarked, “I don't think the robot can help me”. Engagement often increased once interactions began, particularly when the robot communicated in students' native languages. At the same time, responses ranged from praise (“you did a great job!”) to discomfort (“too creepy”), and some students preferred to observe rather than participate. Despite these mixed reactions, the robot successfully supported common tasks such as local tax queries and bank letters, demonstrating practical utility alongside social challenges.

These observations provide the foundation for understanding how multilingual interaction shapes user experience. A key finding is the strong alignment between field and lab study results. This convergence is supported by the absence of statistically significant differences in SASSI scores between the two settings for Mandarin speakers (Fig. 4.19(c)), underscoring consistent user satisfaction with the multilingual system.

As in the lab study, the absence of a baseline comparison condition is a limitation. Robot helpfulness ratings should therefore be interpreted as subjective assessments. They do not provide evidence of improved performance relative to alternative interfaces.

Despite this limitation, having established this consistency, we now consider the broader implications for inclusion and belonging. Beyond usability, the project illustrates how multilingual technology can foster this sense of inclusion. By providing access to essential information in students' native languages, the robot reduces reliance on peers or online translators and empowers international students with limited English proficiency to navigate university life independently. Its presence also helps normalize multilingual interaction within the university environment, signaling institutional support for linguistic and cultural diversity. This combination of practical assistance and a visible sign of institutional support strengthens students' sense of agency and belonging, reinforcing that they are valued members of the University of Glasgow community.

These benefits align with staff perspectives and national concerns about international student support. Interviews with Student Services staff further highlighted the challenges faced by many international students, particularly those from China, who often struggle with English fluency and rely on friends or Google Translate for communication. Recent research confirms these barriers [170], and the issue has drawn national attention, with The Guardian urging UK universities to provide better support for Chinese students [171]. These findings emphasize the need for multilingual support. Offering information in students' native languages can ease access to services, foster a stronger sense of belonging, and enhance the overall university experience.

Our findings can be contextualized by prior work on technology-based student support (Section 4.1.1). Early examples include Valerie, a receptionist avatar assisting students in English and Brazilian Portuguese through speech and text; although not a robot and only a prototype,

Valerie showed promise, with participants rating dialogue quality at an average of 8/10 [162]. Another example is a multilingual chatbot prototype capable of supporting many languages via translation mechanisms; however, its evaluation focused on a survey of 20 students using exam stress phrases rather than post-interaction feedback [163]. Concerning robots, one study examined NAO for time management and role organization. While performance did not differ significantly between robot, tablet, and human instructor, students found the robot activity more interesting. This study involved Israeli university students interacting in Hebrew, with the robot speaking but requiring tablet-based input [164]. The closest to our work is a week-long in-the-wild deployment of Pepper at a UK university, providing campus guidance in English. Over five days, Pepper was placed inside a large teaching building and a library, engaging in 351 interactions and collecting 59 questionnaires (47 students, 12 staff). Pepper was generally liked by students, and the majority preferred it over a tablet for out-of-hours support [165].

While these systems demonstrate the potential of social robots and multilingual interfaces, prior work has primarily addressed tasks such as campus navigation, stress management, or scheduling. There has been limited attention to bureaucratic support for newly arrived international students, a context where language barriers and procedural complexity are particularly challenging. The student support robot described in this chapter was co-designed with Student Services staff and deployed in the student support center during its busiest period, the opening weeks of the 2024/25 and 2025/26 academic years. It was explicitly designed to empower staff while assisting students with essential administrative and practical needs. This purposeful design and timing allowed the robot to bridge an important gap by combining multilingual assistance with visible sign of institutional support, fostering inclusion and belonging for international students.

## 4.5 Chapter Conclusions

This chapter examined international students at the University of Glasgow, focusing on native speakers of Modern Standard Arabic and Mandarin Chinese. We evaluated a multilingual support robot through two complementary approaches: (1) a controlled lab study and (2) an in-the-wild deployment at a UK university. These studies aimed to address our research questions.

### **RQ1a) Which services do international students need, and how do they currently access them?**

In collaboration with Student Services staff, we identified common challenges faced by new students, such as local tax procedures, printing official documents, and navigating campus. These insights informed the selection of four tasks offered by the robot: *campus directions*, *local tax exemption*, *financial aid*, and *official documents*.

**RQ2a) To what extent are human student support services willing to integrate social robots into their offerings?**

Support staff suggested that the robot could assist new arrivals with routine tasks, such as opening a bank account, freeing staff to focus on more complex issues. However, they raised an important question, that remained unresolved: *What would an international student choose when faced with both a robot and a support officer?* Overall, interviewees expressed comfort with the robot's presence and noted that interacting with a physical robot might be easier for students than searching online. Managers acknowledged that robots cannot replace staff but recognized their reliability (never sick or late) as a potential advantage. Opinions remained positive or improved after observing the robot in action.

**RQ3a) Do international students prefer accessing services in their native language, even when provided by a robot?**

Findings from the controlled lab study indicate that international students consistently chose to interact with the robot in their native language, provided positive feedback, and often performed better when using their own language. Similarly, in the in-the-wild deployment at the student support center, task feedback, SASSI responses, and robot helpfulness ratings mirrored these results. These outcomes highlight the importance of multilingual capabilities in fostering usability and user satisfaction, reinforcing the role of language as a key factor in inclusive service design.

Taken together, these findings demonstrate that multilingual social robots can address practical challenges, support institutional goals, and enhance the experience of international students. This chapter provides a foundation for future work on integrating language-aware technologies into student services.

# Chapter 5

## The Bilingual Refugee & Asylum Seeker Support Robot

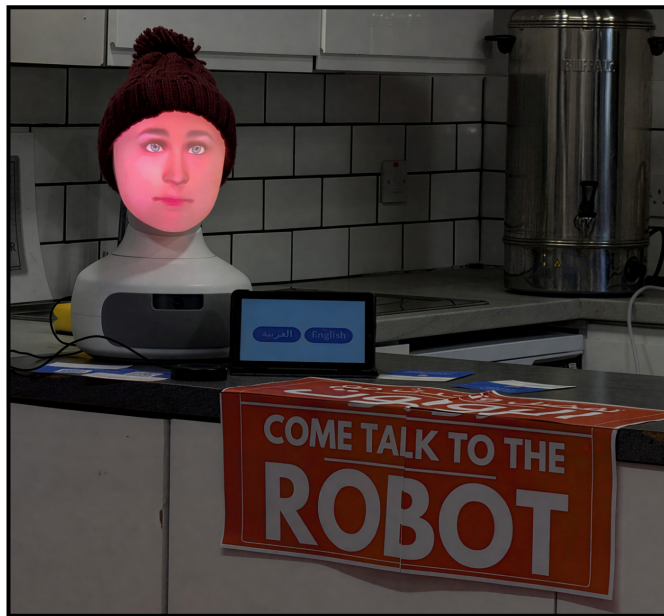


Figure 5.1: The robot system

### 5.1 Chapter Introduction

This chapter examines how social robots can support refugees and asylum seekers (RAS) in accessing essential services during resettlement. Building on the previous chapter's focus on multilingual support for international students, we now turn to displaced populations, who face additional challenges such as heightened vulnerability and complex integration needs. To address these issues, we present the design and deployment of a bilingual robot that communicates in Modern Standard Arabic and English, developed in collaboration with local stakeholders.

Through two complementary studies: (1) a participatory design process and (2) an in-the-wild deployment, we investigate user needs, attitudes, and real-world performance within a drop-in service context.

### 5.1.1 Motivation and Related Work

Understanding the distinctions among people on the move is critical for situating HRI in migration and integration contexts. According to Amnesty International, *the terms refugee, asylum seeker and migrant are used to describe people who are on the move, who have left their countries and have crossed borders* [172]. **A Refugee** is a person *forced to flee their own country and seek safety in another country. They are unable to return to their own country* [173]; **An asylum-seeker** is a person who is *seeking international protection. Their request for refugee status, or complementary protection status, has yet to be processed, or they may not yet have requested asylum but they intend to do so* [174]; **A migrant** is a person who *moves away from his or her place of usual residence, whether within a country or across an international border, temporarily or permanently, and for a variety of reasons... Note: At the international level, no universally accepted definition for migrant exists* [175].

Across the UK, non-government organizations (NGOs) such as Refugee Action and Migrant Help play a central role in supporting and caring for RAS across the UK [176]. In Scotland, these efforts are complemented by the *New Scots Refugee Integration Strategy*, a collaborative effort by the Scottish Government, COSLA (the Convention of Scottish Local Authorities), and the Scottish Refugee Council (SRC), aimed at supporting RAS in Scotland. The term “New Scots” was chosen as it *“conveys a helpful message of inclusion to all who need safety in Scotland for as long as they need it”* [177]. The SRC provides refugees with a welcome package translated into five languages, including Arabic, containing essential information about emergency services, benefits, healthcare, finance, and more [178]. However, due to significant mental strain and distress caused by displacement, many refugees were unable to focus on the package contents, despite its informative nature [179].

To better understand the experiences of RAS, researchers have conducted focus groups and interviews, often with the assistance of translators. For instance, focus groups with refugees from conflict-affected regions, such as Somalia and Ethiopia, identified key barriers to discussing mental health, including factors such as a history of political repression, fear, lack of knowledge, and shame [180]. Other studies, conducted in Germany and Turkey have further examined the challenges Syrian refugees face in accessing services. Participants reported being unable to book appointments over the phone due to limited host language proficiency [181], or being unaware of available services in their own language [182]. In Scotland, interviews with Syrian refugee families highlighted socio-cultural differences as major barriers to accessing services [179]. A year-long design research project conducted in informal Syrian refugee settlements in Lebanon emphasized the crucial role of NGOs in building trust between researchers

and participants [183].

Participatory design with social robots has matured across multiple user groups, including older adults [114], children [115], and blind people [116], yet remains comparatively scarce with migrants and RAS. Notable exceptions include interviews with teachers at an international primary school in Switzerland that proposed social robots to support inclusion of migrant-background children [184], and a co-design effort with Middle Eastern refugees and professionals to develop an egg-shaped robot prototype for integration support in Portugal [185]. More broadly, recent HRI studies with RAS have explored acceptance among Syrian refugees [186], language learning with Ukrainian child refugees [187], robot-mediated translation for integration [185], and protective robot swarms in migration contexts [188]. Together, these works demonstrate potential while revealing gaps in *participatory design*, *multilingual accessibility*, *service navigation*, and *field deployment* alongside human staff.

Building on this background and addressing the gaps in multilingual service access and real-world integration, we revisit the overarching research questions of this thesis:

**RQ1)** Which services do newcomers need, and how do they currently access them?

**RQ2)** To what extent are human support services willing to integrate social robots into their offerings?

**RQ3)** Do newcomers prefer accessing services in their native language, even when provided by a robot?

We developed a bilingual RAS support robot that communicates in Modern Standard Arabic and English. Designed for deployment at a drop-in service supporting displaced people in the city of Glasgow alongside human staff, the robot provides relevant information about libraries and food hubs, which are community organizations offering food free of charge or at a reduced cost.

### 5.1.2 Chapter Structure

This chapter begins by presenting the motivation and methodological approach tailored to the RAS population. It then describes stakeholder consultations with CWIN charity staff, which informed the design of the bilingual robot. Next, it details two complementary studies: a participatory design study exploring user needs and attitudes, followed by an in-the-wild deployment assessing real-world performance. Each study includes its research questions, results, discussion, and conclusions. The chapter concludes with a summary of key findings and implications for bilingual accessibility.

### 5.1.3 Methods Overview

This chapter employs two complementary methodological approaches to address the research questions for the RAS population. The Refugee Co-Design Study employed qualitative methods, including focus groups and questionnaire analysis, to explore user needs and attitudes toward social robots. The Refugee In-The-Wild Study focused on technical development and in-the-wild deployment, involving the design and implementation of new software for a bilingual robot and its integration into a drop-in service. These approaches were chosen to capture both user perspectives and real-world performance. Detailed methods for each study are presented in Sections 5.3.1 (Refugee Co-Design Study) and 5.4.1 (Refugee In-The-Wild Study).

### 5.1.4 Studies Overview

We evaluated the bilingual support robot through two complementary approaches: (1) a participatory design study with Syrian RAS, and (2) an in-the-wild deployment at a drop-in service supporting displaced people.

#### Study 3: Refugee Co-Design Study

The study aimed to assess the needs of this group, as well as their overall attitudes toward robots. We carried out two focus groups where the participants were invited to share their perspectives in Levantine Arabic, their native language, with the goal of co-designing a social robot that addresses their specific needs and enhances their well-being. The first group took place in December 2024 with six men, and the second in March 2025 with three women. Each session lasted two hours and was held at a multicultural center in Glasgow.

#### Study 4: Refugee In-The-Wild Study

To complement the co-design findings and evaluate real-world performance, we developed and deployed a bilingual social robot speaking Modern Standard Arabic and English. The design incorporated insights from the Refugee Co-Design Study and consultations with staff at the CWIN charity. The pilot version of the robot primarily provided information about libraries and food hubs operating in the city.

## 5.2 Stakeholder Consultations

Unlike the studies in the previous chapter, where the researcher acted as a *participant observer* and engaged closely with the role of an international student, the RAS use case required a different approach. Here, the researcher volunteered with the Central and Western Integration Network (CWIN) and adopted the role of an *observant participant*, positioned closer to the

perspective of service providers and charity staff (for a distinction between these terms, see Section 3.5).

This involvement facilitated trust and enabled the researcher to coordinate a group meeting with CWIN staff to present the robot. During the session, staff observed the robot in action, demonstrating an example dialogue from the student support project (providing information about local tax exemption). This demonstration prompted staff to suggest several potential tasks for the robot. The design goal was to ensure the robot offered practical value rather than relying on predefined assumptions. Consequently, the task specification underwent several iterations before being finalized as providing information on libraries and food hubs. These consultations offered direct insight into support practices and informed the design and deployment of the bilingual robot.



Figure 5.2: Syrian women observing the robot system in action

## 5.3 Refugee Co-Design Study

### 5.3.1 Overview

One of the largest refugee crises is in the Syrian Arab Republic, where over 6 million Syrians have been displaced from their homeland [189]. According to the UK Home Office, Scotland has received around 16% of the 20,319 Syrian refugees placed in the UK under the Vulnerable Persons Resettlement Scheme [190]. In addition, the Scottish Refugee Council (SRC) reports that approximately 650 Syrians in Scotland currently have pending asylum applications [191].

We developed a social robot designed to meet the needs of displaced Syrians in Scotland. As part of the design process, we collaborated with a Scottish charity supporting refugees. Through

the charity, we recruited nine Syrian Refugees and asylum seekers (RAS) currently residing in Glasgow. We carried out two focus groups where the participants were invited to share their perspectives in Levantine Arabic, their native language. The goal was to co-design a social robot that addresses their specific needs and enhances their well-being.

### Research Questions

Based on previous literature on second-language interaction described in Section 2.1, this study addresses overarching **RQ1** and **RQ3** for the specific case of Syrian RAS. To do so, it examines the following study-specific research questions:

**RQ1b** Which services do Syrian RAS need, and how do they currently access them?

**RQ3b** Do Syrian RAS prefer accessing services in their native language, even when these services are provided by a robot, and how does the robot’s appearance (e.g., perceived gender and religious attire) influence this preference?

**RQ4** Does observing the robot in action lead Syrian RAS to hold more positive attitudes towards using it to access services?

### Participants

The focus groups involved a total of nine Syrian RAS currently living in Glasgow, UK (Table 5.1). We collaborated with *Central and Western Integration Network* (CWIN<sup>1</sup>), a Scottish charity supporting refugees, asylum seekers and migrant workers throughout Glasgow, where the researcher has been volunteering with the drop-in service for the last three years. In the last year, 152 individuals from Syria have come to CWIN to participate in their activities and to seek support (30% women). Participants were recruited through the charity’s different WhatsApp groups and through posts on Facebook.

### Methods

The Arabic recordings of the two focus groups were transcribed using Whisper [192], then divided into speakers in the Speaker Diarization process using Pyannote.Audio [193]. The diarized transcripts were then translated into English using DeepL Pro, a secured online translator [194]. The transcripts and the English translations were verified by the interviewer. Following the six steps outlined by Braun and Clark [195], we then generated codes and themes.

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<sup>1</sup><https://www.cwin.org.uk>

ID	Age	Gender	Civil Status	Education	Residence Status	Living Situation
M1	35	Man	Single	Middle School	Refugee	Alone
M2	36	Man	Single	University	Refugee	Alone
M3	39	Man	Single	University	Refugee	Alone
M4	31	Man	Single	University	Refugee	Alone
M5	43	Man	Married	Primary School	Refugee	Alone
M6	48	Man	Married	University	Refugee	With family
W1	34	Woman	Married	University	Asylum Seeker	With family
W2	41	Woman	Married	University	Asylum Seeker	With family
W3	37	Woman	Married	Middle School	Asylum Seeker	With family

Table 5.1: Participant Demographics

The Negative Attitude toward Robot Scale (NARS) [196] is commonly used to explore populations' acceptability of robots. It is classified into 3 subscales:

**S1:** *Negative Attitude toward Situations of Interaction with Robots.*

**S2:** *Negative Attitude toward the Social Influence of Robots.*

**S3:** *Negative Attitude toward Emotions in Interaction with Robots.*

We translated the NARS questionnaire into Arabic for use in the study (see Fig. C.1 in the appendix). Participants completed it before and after observing the robot system in action, and their responses were compared to explore trends in their attitudes. Each statement was evaluated on a 7-likert scale (1=Strongly Disagree, 7=Strongly Agree). Scores for positively worded statements were reversed (e.g., 1=7, 2=6). For each participant, we calculated three average scores, one for each subscale, for both the *before* and *after* phases. This resulted in 27 data points per phase.

## Procedure

Two focus groups were conducted in Levantine Arabic by a colleague, *Rawan Srouf-Zreik* (hereafter 'the interviewer'), a native speaker: this is notable, as previous studies have shown that using interpreters can interrupt the flow of conversation and cause distractions [197], while a shared language between researcher and participants fosters trust [78]. The first group took place in December 2024 with six men, and the second in March 2025 with three women (Figure 5.2). Each session lasted two hours and was held at a multicultural center in Glasgow, where the CWIN charity is based.

As part of each focus group, participants were shown the multilingual student support robot system described in Section 3.1.

Participants in each focus group were welcomed to a designated room, where they were told that they will be asked about access to services and their views about robots and AI. They



Figure 5.3: The Furhat robot dressed up in a head scarf

then filled in the NARS questionnaire, containing 14 statements concerning the negative attitude toward robots. They were asked about the difficulties they had when they arrived in the UK, and a discussion started. Afterwards, they were shown the robot system, with two interactions concerning local tax exemption, first in Arabic, and then in English, to showcase the system’s multilingual capabilities. The robot’s appearance was modified by first dressing it with a wig and a hijab (see Figure 5.3), and then switched to a bearded face with a hat. They were asked about using the robot to assist them and about its appearance. After the system introduction, they filled the NARS questionnaire again. All participants were compensated for their participation with a £20 shopping voucher.

### 5.3.2 Qualitative Results

We report four themes: 1) *Experiences of RAS* with subthemes: a) Housing Insecurity b) Displacement and Uncertainty; 2) *Barriers to Services* with subthemes: a) Language Barriers b) Bureaucratic Complexity and Information Gaps; 3) *Existing Support Systems*; 4) *Exploring Potential Support Solutions* with subthemes: a) Interaction Style b) Robot Appearance and Perception. The first three themes were identified in the transcript of the discussions prior to the robot demonstration, while the fourth theme primarily occurred in the discussion afterward.

## Experiences of RAS

This theme captures participants' lived experiences prior to arrival and during resettlement, and is organized into two subthemes: housing insecurity and displacement with associated uncertainty.

**Housing Insecurity.** Housing insecurity is a common challenge faced by RAS. Participants described times without housing or work—and even when they were housed, it was often temporary, as one stated “*God willing, you will be in the hotel. We stayed for about a month. Then we got a temporary house*” (W2). The feeling of helplessness and lack of agency was emphasized in the words of another participant, “*this is one of the first difficulties, the most difficult one, which means you spend a week or two without a home and without a job*” (M4).

**Displacement and Uncertainty.** Participants discussed reasons for leaving Syria and looking for a new host country, “*because of the war and destruction, people were displaced, it wasn't an economic reason, it was a political reason, people were afraid for themselves and their lives*” (M5). A major concern is the long wait for asylum decisions, during which they may face detention and have to rely on lawyers to speak with authorities. They fled Syria for a better future, yet remain at the mercy of others: “*it depends on the official officer who investigates and takes the case, and based on the evidence you give him, he decides whether you deserve asylum or not*” (M4).

## Barriers to Services

This theme captures key challenges faced by RAS when accessing services and is organized into two subthemes: language barriers, and bureaucratic complexity with associated information gaps.

**Language Barriers.** The language barrier was especially pronounced when participants had to use the phone to book appointments, a situation that leads to frustration or being dependent on one's community and friends. “*I'd have to get a friend who speaks English and they only accept reservations from a private number, so I have to call a friend to book me a GP appointment*” (M1) or “*as for the GP, it's difficult to call at exactly 8:30am, and you can't go in person they don't answer the phone, you can only book for the same day, and there's no interpreter*” (M5). Fluency in English is either required or highly favorable for university study or employment. While ESOL (English for Speakers of Other Languages) courses are available for free, they often have long waiting lists, and individuals may wait up to a year before they can begin. “*there are young people here who say that they had to wait, for example, 6 months or 8 months until they were accepted*” (M3).

**Bureaucratic Complexity and Information Gaps.** Participants also described difficulties navigating bureaucratic processes, particularly when requirements were unclear or conflicting. For example, registering with a GP without a fixed address was especially challenging: “*When you apply for asylum, they're supposed to understand your situation that you're new to the*

country and don't know your way around... The problem is, when you try to register with a GP, you need a proof of address. But when we first arrived, we didn't have one... It took a long time before we could finally register" (M1). These challenges were compounded by the absence of reliable and accessible information. They had to rely on their wit and knowledge in order to find their way around: "there was no one to help us, no one to inform us. No organization or official body shared this information with us we had to find out on our own, and only managed because we were educated" (W1).

### **Existing Support Systems**

Participants acknowledged the importance of local NGOs and charities operating in Glasgow. They often text or email them in order to receive support. As one participant explained, "If I have an application form that I don't understand, I can send it (to the SRC) on WhatsApp or if I want, for example, Travel Documentation, if I don't know how to make the application, they will help me" (W2).

On the other hand, there are many organizations which help, but each is responsible for a different aspect, so it can be difficult to know where to go and for what purpose: "when you try to call, they either say it's full, say no, or don't answer—because you don't speak English. So you have to go to an organization for help, but then they refer you to another one, or give you appointments weeks in advance, or add more steps. There's no single organization that provides everything, so the information really needs to be centralized" (M4).

The participants expressed interest in having a single platform having all the information in one place. Specifically, regarding ESOL course enrollment, they suggested having a list of nearby colleges offering such courses, "if all the information is there the names of the colleges, the levels, the registration times, things like that. So it can be useful for refugees" (M5). They also emphasized the need for support with registering at a doctor's clinic.

### **Exploring Potential Support Solutions**

This theme was identified through analysis of discussions that followed participants' interaction with the robot and demonstrations in Arabic and English. It is organized into two subthemes: interaction style, and robot appearance and perception.

**Interaction Style.** While the participants understood that the focus was on an Arabic-speaking robot, they emphasized the importance of making it multilingual to support other refugee groups: "the robot provides services to Syrian refugees who speak Arabic, it should also provide services to the Kurdish brothers who speak Kurdish" (Man, 45). Participants added that they would like it to be polite and empathetic, and discussed the positive aspects of using a robot: "it can be embarrassing if you talk to a person, but if you talk to a robot... there's a comfort level" (W1).

**Robot Appearance and Perception.** The participants were amused by the robot’s appearance, but they did not display a preference to a gender or an attire. *“it’s important that it gives me the result I want in the end... Sometimes, you feel that some people trust a man more when he’s the one speaking like the information feels more accurate and convincing. But others who, on the contrary, feel more comfortable if it’s a woman”* (W3).

Across both subthemes, participants also highlighted broader service needs and suggested potential extensions of the system. In particular, they emphasized the importance of having services such as ESOL course registration and access to official information available in a single location. In addition, they suggested that the robot could assess students’ English proficiency: *“The robot can determine the level of the student and start working with him or guide him forward”* (Man, 48). More generally, participants felt that any solution complementing existing services would be valuable, as one noted, *“this is a very positive step that will make it easier for RAS to access services very quickly.”* (M1).

### 5.3.3 Quantitative Results

Figure 5.4 shows the overall NARS scores of participants before and after they observed the robot system. Participants’ attitudes toward interaction with robots were generally positive, with average scores of 2.85 before and 2.8 after the observation. Their attitudes toward the social influence of robots were neutral, with average scores of 4.16 before and 4.36 after the observation. Lastly, their attitudes toward emotions in interaction with robots were neutral before the observation, average score of 4.33, and it was a bit more positive afterward with an average score of 3.44.

To control for multiple comparisons, we applied the Bonferroni correction, adjusting the significance threshold for all tests to  $\alpha = 0.0167$ . Paired t-tests did not find significant differences in any of the subscales (S1:  $t(8) = 0.15, p = .88, d = .06$ ; S2:  $t(8) = -0.35, p = .73, d = -.16$ ; S3:  $t(8) = 2.07, p = .073, d = .91$ ). Thus, with this very small data sample, we were unable to find quantitative evidence to address RQ4.

### 5.3.4 Discussion & Conclusions

In the discussions prior to showing the robot to the participants, three primary themes were identified: 1) *Experiences of RAS*; 2) *Barriers to Services*; 3) *Existing Support Systems*. Discussion on all of these themes addressed RQ1b regarding the services that Syrian refugees access and the way that they currently access them. The results also agree with previous research carried out in different host countries on the needs and challenges faced by RAS (e.g., [180, 182]), which is relevant to this group in Scotland. In the fourth theme identified after the robot demonstration, *Exploring Potential Support Solutions*, participants addressed RQ3b and were positive about using the robot as a complement to existing services delivered in their native language.

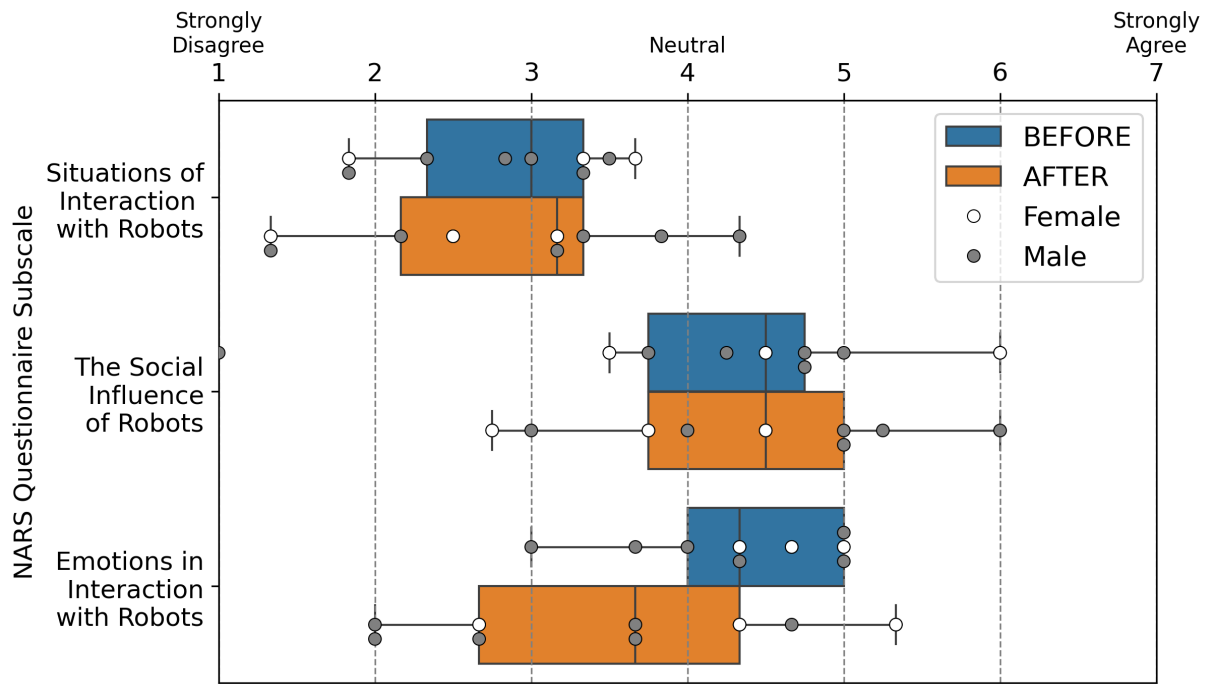


Figure 5.4: Negative Attitude Toward Robots (n=9) [1=positive; 7=negative]

Finally, participants' overall attitudes toward the robot ranged from neutral to positive, with no significant differences between before and after the demonstration, likely due to the small data sample used, and no evidence was found to address RQ4.

The experiences participants shared concerning housing insecurity and being displaced were also observed in previous work (e.g., [46, 47, 48]). The major barriers to accessing services identified were language and bureaucratic knowledge gaps. Participants expressed a strong preference for communicating in their native language, Arabic, due to the difficulties posed by having to rely on others. This observation aligns with existing literature and has been reported among refugees in Turkey, Germany and Scotland (e.g., [181, 182, 49]). Concerning bureaucracy, our data is also similar to previous findings (e.g., [50]). In the third theme, participants recognized the value and limitations of support from local charities, in relation to their own personal challenges. Similar claims were made in previous studies (e.g., [176, 183, 179]). These discussions revealed the services most important to them, particularly ESOL registration and access to healthcare, thereby addressing RQ1b. They also emphasized the need for a reliable source of official information, ideally a unified platform.

Discussions continued after the participants observed the robot and examples for support interactions in Arabic and English. Participants explored potential support solutions, and indicated they would willingly use a robot, regardless of its gender or religious appearance (RQ3b).

While a previous study using the NARS questionnaire reported fairly positive attitudes toward humanoid robots among Arabs who were not displaced [198], this study found similarly neutral to positive attitudes among Syrian refugees. This suggests that positive perceptions of

humanoid robots may persist even in the context of displacement (Figure 5.4). Having observed the robot in an interaction with the interviewer, both in Arabic and English, did not change their attitude significantly (RQ4).

In conclusion, this study engaged RAS in the first co-design process of a social robot aimed at addressing their bureaucratic needs. In a qualitative thematic analysis, we found that participants in our focus groups reported similar challenges that have been found in previous studies. When introduced to the idea of a social robot as a complement to existing support systems, participants were willing and enthusiastic about the robot addressing their needs, which was especially encouraging.

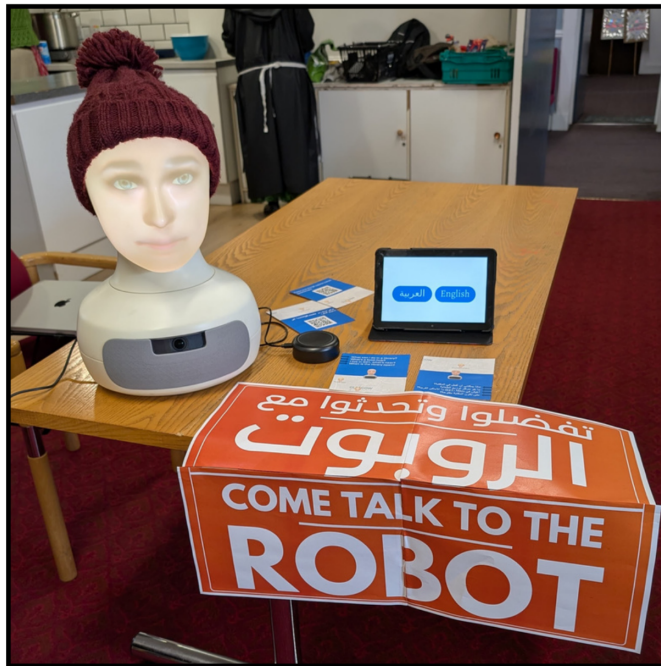


Figure 5.5: Furhat in the multicultural center

## 5.4 Refugee In-The-Wild Study

### 5.4.1 Overview

To complement the co-design findings and evaluate real-world performance, we developed and deployed a bilingual social robot speaking Modern Standard Arabic and English. The design incorporated insights from the Refugee Co-Design Study and consultations with CWIN charity staff. It was not feasible to implement the services identified as most needed by RAS (**RQ1b**), namely access to healthcare and ESOL course registration. These findings nevertheless shaped our broader aim to support RAS from Syria as well as other regions represented at CWIN. The pilot was conducted over three non-consecutive days between late August and late September

2025. During this period, the robot provided information about local resources such as libraries and food hubs.

### Research Questions

Building on the language-related challenges discussed in Section 2.1, this study addresses overarching **RQ1**, **RQ2** and **RQ3** in the context of RAS interacting with a social robot in a public service space. Specifically, we examine the following study-specific research questions:

**RQ1c** Which services do RAS need, and how do they currently access them?

**RQ2b** To what extent are human support services for RAS willing to integrate social robots into their offerings?

**RQ3c** Do RAS prefer accessing services in their native language, even when these services are provided by a robot?

### Participants

A total of 14 RAS participants interacted with the robot during CWIN charity activities at the multicultural center in Glasgow, UK (e.g., sewing group, community meal). Five chose to interact in Arabic, while all provided immediate feedback using Happy/Neutral/Sad ratings; seven also completed the SASSI questionnaire. Participants were predominantly women (71%), with one participant not reporting their gender. Ages ranged from 22 to 51 years (mean age = 36.28,  $SD = 9.86$ ). Reported native languages included Arabic (2), Otjiherero (1), Vietnamese (1), Bengali (1), Mayan (1), and Spanish (1). Additional demographic details are presented in Table 5.2.

Although the sample was small, both Task Feedback and SASSI responses were broadly consistent with findings from the Student Lab & In-The-Wild studies. Participants generally enjoyed interacting with the robot; however, interactions appeared less direct and intuitive compared to those observed with international students.

ID	Age	Gender	Native Language	Country	Education	Time in UK
1	40	Woman	Arabic	Jordan	University	–
2	35	Woman	Arabic	Syria	University	–
3	32	Woman	Otjiherero	Namibia	High school	2 years
4	29	Woman	Vietnamese	Vietnam	University	1 year
5	22	Woman	Bengali	India	University	1 year
6	45	Unreported	Mayan	Latin America	High school	5 years
7	51	Man	Spanish	Colombia	University	16 months

Table 5.2: Participant Demographics

## Procedure

The robot was positioned on a table with clear signage to attract attention and indicate its purpose, ensuring visibility within the multicultural center. Deployment occurred over three non-consecutive days between late August and late September 2025. Due to delays in obtaining permission to operate during drop-in service hours, the first two sessions were held during multiple CWIN activities. During these sessions, RAS visitors were free to interact with the robot at any time. Figure 5.5 shows the robot during the real-world deployment. In the third and final session, the robot was placed in the drop-in service area alongside human staff. Visitors were invited to engage with the robot and ask about local resources such as libraries and food hubs. At the end of each session, participants provided immediate feedback via the tablet interface and were invited to give informed consent to complete a longer online questionnaire, which included a subset of the SASSI items, demographic questions, and a single-item prompt for suggestions for improvement.

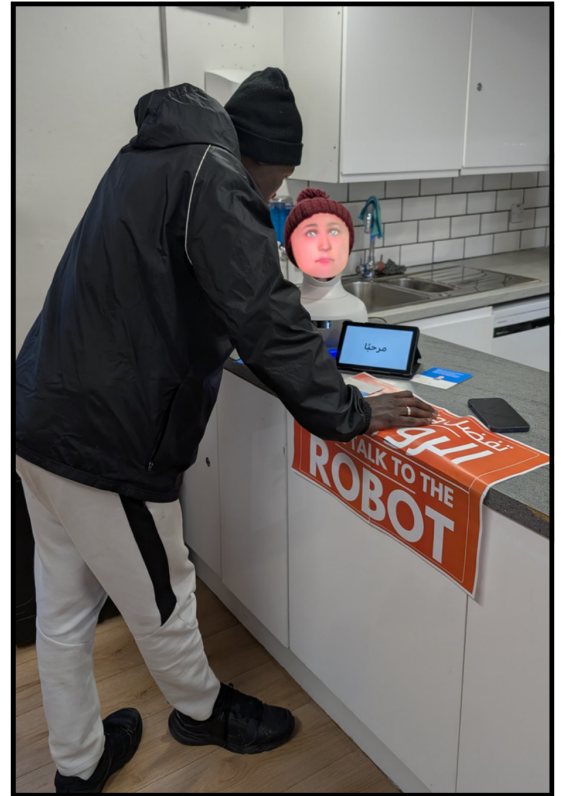


Figure 5.6: A RAS visitor interacting with the Furhat robot

## Methods

The robotic system (Fig. 5.1) is described in detail in Section 3.1. For this study, the dialogue manager was implemented in Python [166] and combined a large language model (LLM) with Retrieval-Augmented Generation (RAG) [199]. This architecture enabled task-oriented yet flexible interactions with users (Fig. 5.7).

The interaction begins with the robot presenting the topics it can assist with. Users then pose questions in natural language in their preferred language. Intent classification and response handling were supported by a language model, as described in Section 3.1, enabling flexible interpretation of user input while maintaining task focus.

Service information was sourced from publicly available data provided by the *Glasgow Community Food Network*<sup>2</sup> and *Glasgow Life*<sup>3</sup>. The researcher generated HTML pages for each post-code prefix (G1–G90) and used *GeoPandas* [200] and *Contextily* [201] to create maps annotated

<sup>2</sup><https://glasgowfood.net/community-food-hub/find-local-food-services>

<sup>3</sup><https://www.glasgowlife.org.uk/venue-finder?channel=Libraries>

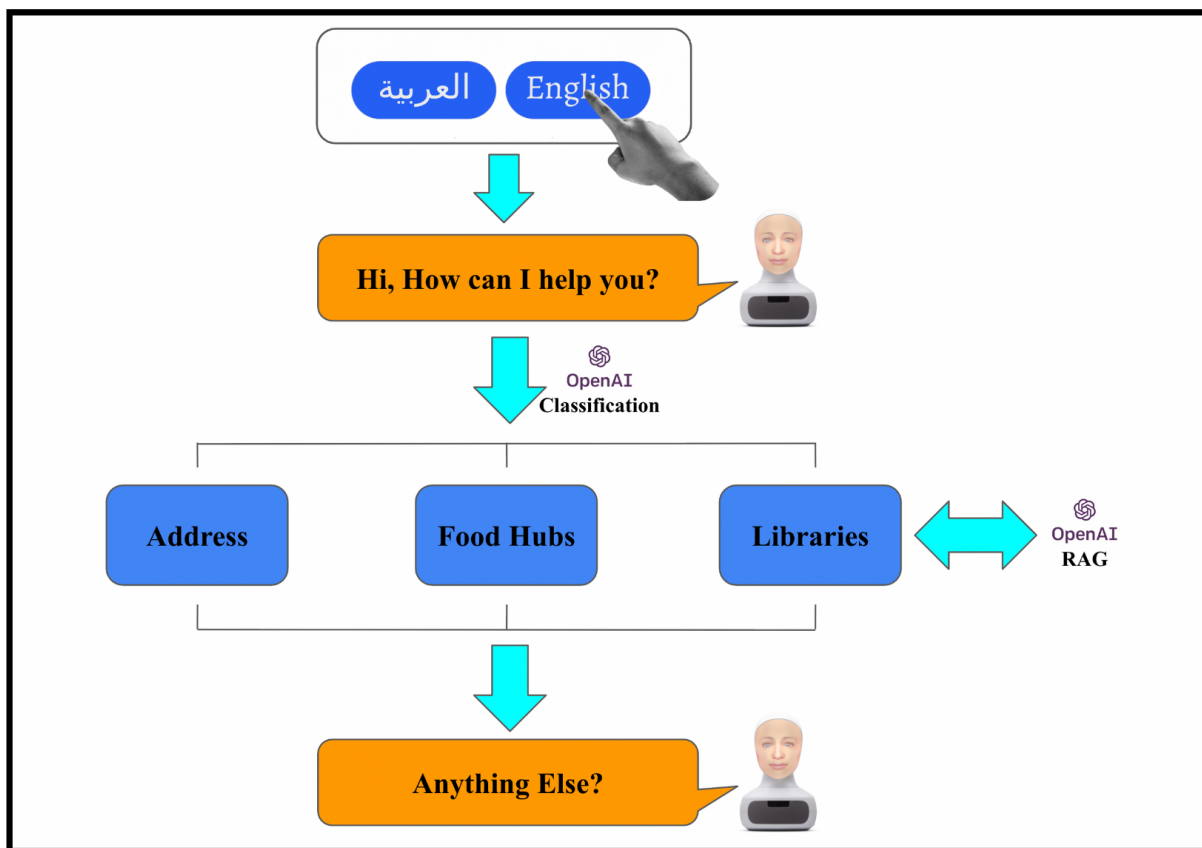


Figure 5.7: High-level dialogue flow using RAG

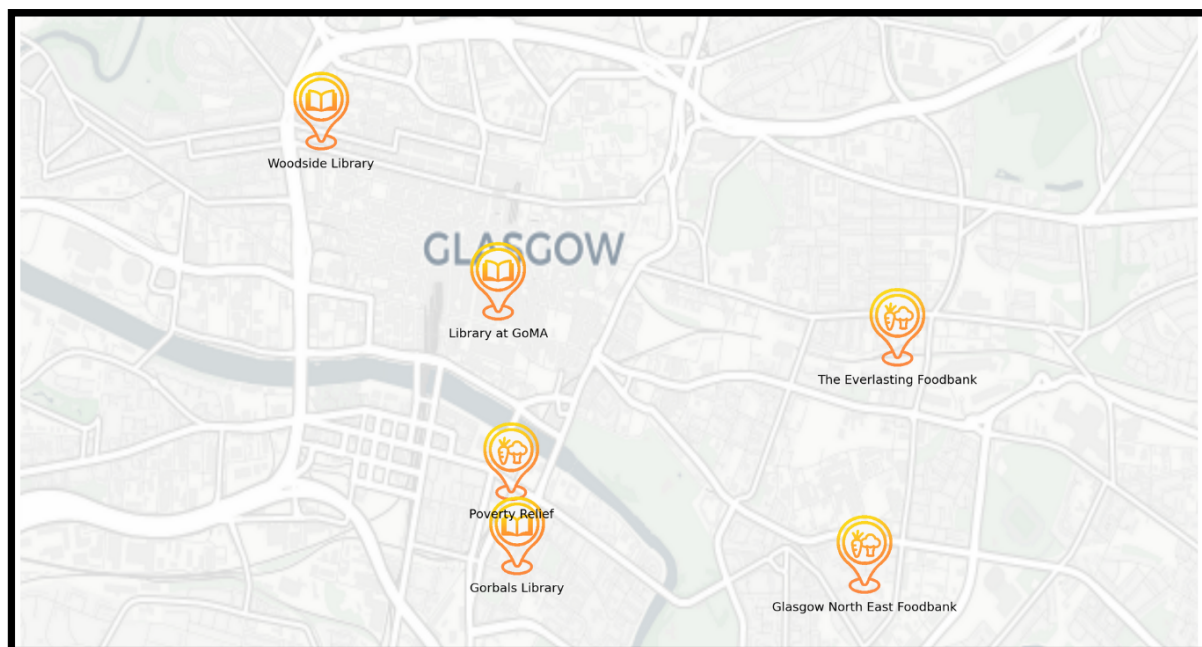


Figure 5.8: Automatically generated map showing services near the G1 postcode

with food hubs and libraries (Fig. 5.8).

The primary goal of the dialogue was to provide actionable information. Users supplied the

first part of their postcode, and the robot displayed a QR code linking to a map with service descriptions and Google Maps links (Fig. 5.9). This design ensured that interactions remained concise while offering extended details via mobile access.

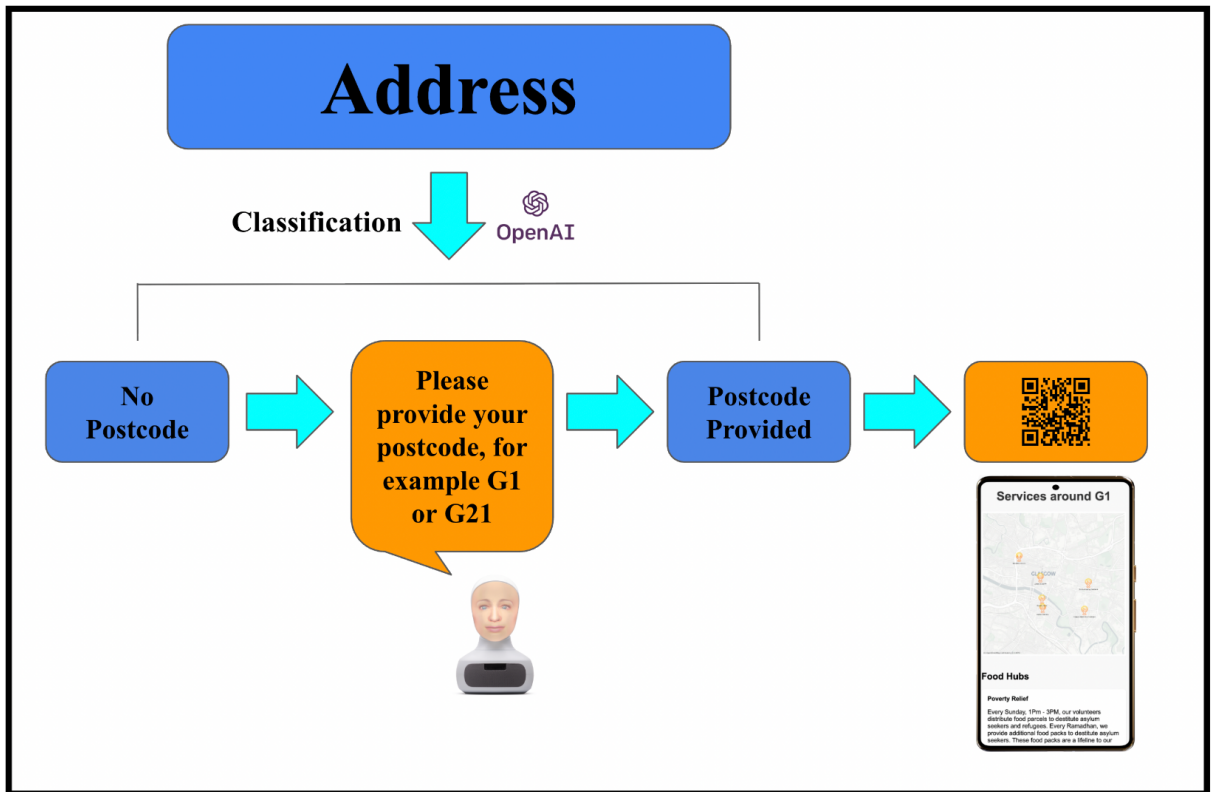


Figure 5.9: Dialogue flow for neighborhood-specific services

## 5.4.2 Qualitative Results

Connectivity issues were a recurring challenge in the building, sometimes disrupting interactions entirely, as the robot relied on the OpenAI API to process user input. These limitations shaped the overall experience and were reflected in participant feedback.

In the optional post-study questionnaire, participants suggested improvements addressing both technical and interaction-related aspects. Several highlighted the need for faster responses and more reliable connectivity, noting, e.g., “*Speed in responding and answering diverse questions*”, while another simply wrote: “*Internet mejorar*” (Spanish for “improve internet”). These comments suggest that delays, whether due to processing or network issues, were noticeable and impacted the experience.

Beyond technical performance, participants expressed enthusiasm for the concept and a desire for broader availability, with one remarking: “I wish we had more robots that can help us and that are friendly”. This highlights a positive attitude toward social robots as supportive tools in community settings.

Participants emphasized the importance of making interactions feel more natural and engaging. Suggestions included adding eye contact and conversational cues to create a more human-like experience: “*The conversation will be more human if it can repeat or react with the question I asked. Some phrases such as: ‘Hmm that’s a good question!’ or ‘Okay so you’re asking me about...’ would make the conversation more engaging*”.

While these responses reveal RAS participants’ perceptions of interaction quality, observations in the center provided additional insight into how visitors engaged with the robot in practice. Similarly to the behavior observed among students in the university support services (Section 4.4.2), the robot attracted attention in the multicultural center, though not all visitors were eager to engage. Many displayed curiosity during activities such as the sewing group and community meal, approaching the robot to observe or comment. One visitor remarked that the robot looked “more human with a hat”, suggesting that appearance influenced perceptions of social presence. Another visitor emphasized the importance of healthcare information, noting that “GP is important”, mirroring insights from the Refugee Co-Design Study.

Interactions varied across language preferences. A Spanish-speaking couple engaged enthusiastically with the system, despite using English rather than Spanish. In contrast, an Arabic-speaking volunteer expressed dissatisfaction with the use of Modern Standard Arabic instead of a dialect, voiced a general dislike of robots, and ultimately chose not to interact, even though the system was designed for Arabic users. These observations highlight how linguistic and cultural factors, combined with negative attitudes toward robots, shaped engagement.

### **5.4.3 Quantitative Results**

We employed similar measures to those used in the Student Lab & In-The-Wild studies. Here, we report the subjective measures: (1) immediate emoji-based task feedback for all participants, and (2) responses to the SASSI questionnaire for those who completed the online survey.

#### **Task feedback**

Although our sample was small ( $n = 14$ ), immediate feedback captured via Happy/Neutral/Sad emoji responses indicated that most participants in the field study were satisfied with their interaction with the bilingual system. Specifically, 71% (10 out of 14) selected the “Happy” emoji, aligning with results from the Student Lab & In-The-Wild studies (Fig. 4.18(b)).

#### **SASSI results**

Overall, responses to the SASSI questionnaire were consistent with expectations (Fig. 5.11). Participants perceived the system’s Cognitive Demand to be relatively light (mean = 4.82 on a 7-point scale, where 7 indicates lowest demand), Habitability as moderate (mean = 4.03), and

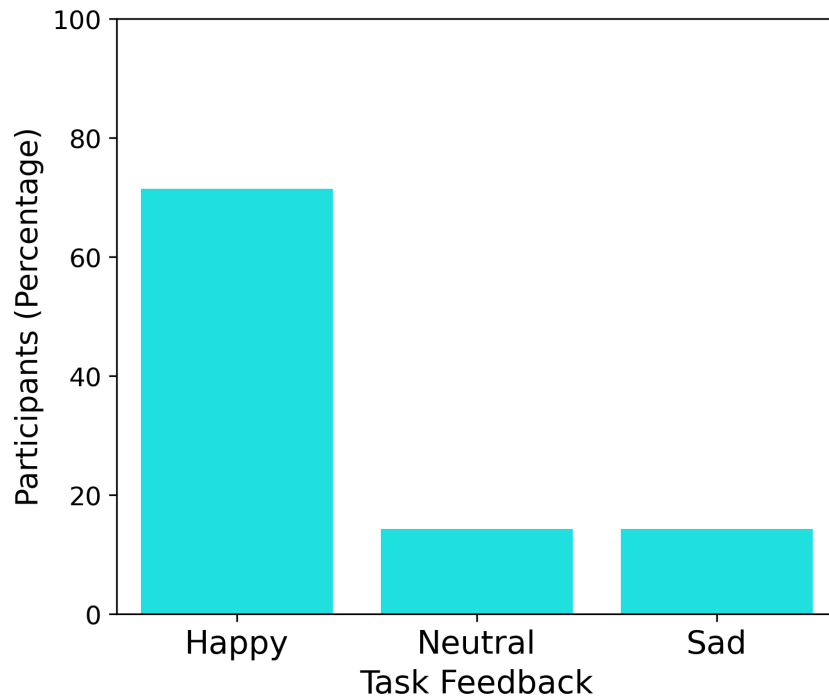


Figure 5.10: CWIN Multicultural Center: Task Feedback ( $n = 14$ )

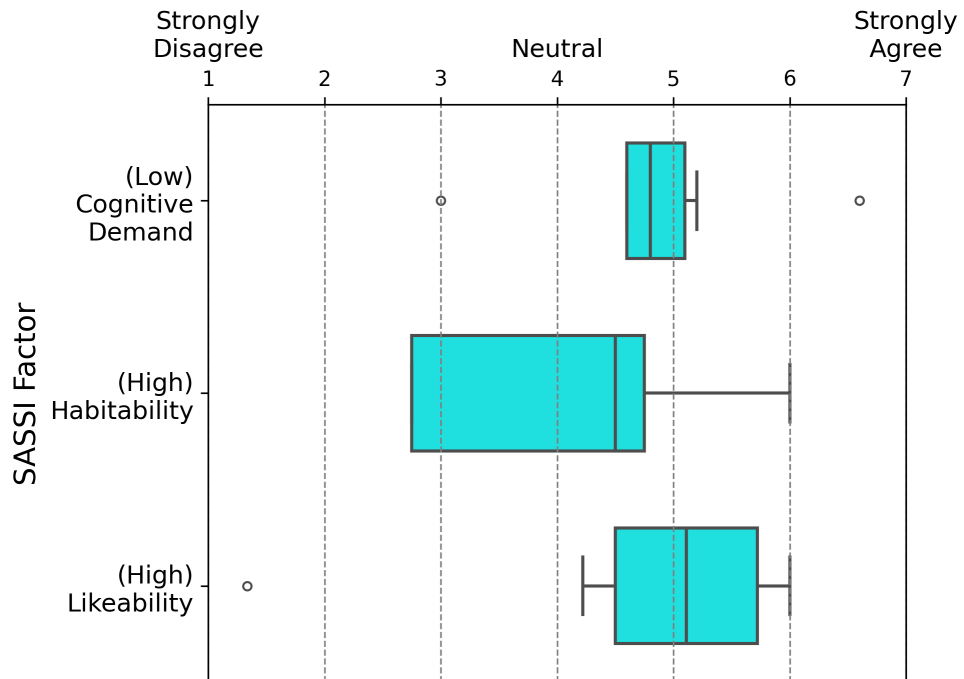


Figure 5.11: CWIN Multicultural Center: SASSI Factor Scores ( $n = 7$ )

Likeability as generally high (mean = 4.69). While these findings suggest that the bilingual system was easy to use and generally well-received, they do not directly indicate a strong preference for native language interaction, as only 2 out of 7 participants conversed in their native language, Arabic. This highlights that positive usability perceptions may stem from the system’s overall

design rather than language matching alone. These results partially address **RQ3c**, but further investigation with a larger sample and more native-language interactions is needed. Given the small sample size ( $n = 7$ ), these findings should be considered exploratory.

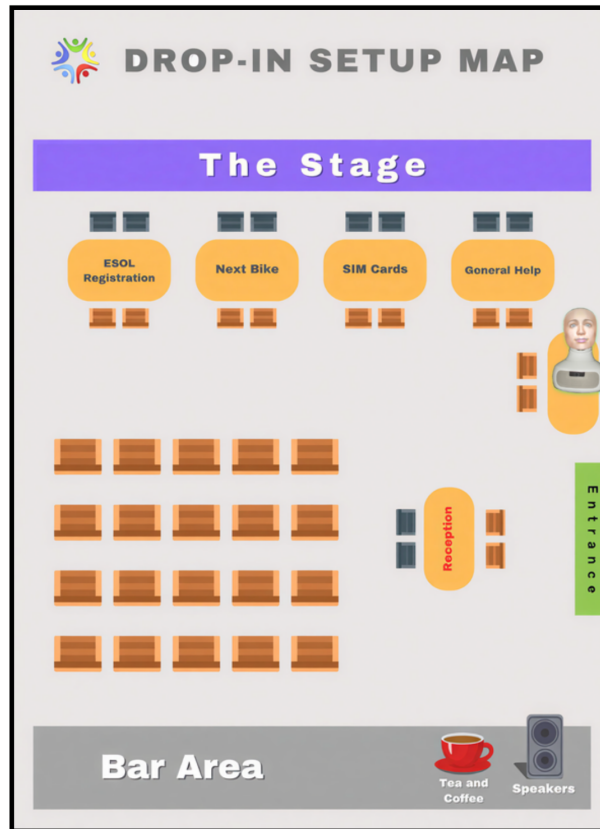


Figure 5.12: CWIN Multicultural Center: Drop-In Setup Map

#### 5.4.4 Stakeholders

The Scottish charity CWIN operates from a multicultural center in Glasgow, UK, offering a range of activities and a weekly drop-in service that provides support and advice on ESOL registration, bike rentals, free SIM cards, and general assistance (Fig. 5.12).

In March 2025, The researcher met with the CWIN staff to showcase a bilingual social robot and explore its potential deployment during drop-in hours. The session began with two demonstrations adapted from an international-student use case: (1) providing local tax exemption instructions and (2) giving directions to the university library. The researcher then presented insights from Syrian RAS focus groups, highlighting recurring challenges such as GP registration and ESOL course enrollment.

He emphasized that the robot was intended as an addition rather than a replacement for human interaction, noting that newcomers often struggle to identify what to search for online and may require trusted guidance. He also clarified that the system would be domain-specific, ethically approved, and designed to operate without storing personal data, while offering practical

features such as QR codes and printed bullet points to support next steps. Finally, he stressed that the robot would be co-designed with staff, limited to a small set of high-confidence tasks, and configured for multiple languages and voices.

Staff responses revealed both enthusiasm and caution. They stressed the importance of trust and relational work: *“People who come here trust us... We’re trusted as a community to be helpful to the members”*. Several staff members questioned whether the robot could fit within one-to-one casework, observing that *“what they [drop-in visitors] need is that one-to-one individual meetings or appointments”* and warning that it could be *“unrealistic to even use it for a week”* if framed as a casework substitute. Concerning the robot speaking in the RAS visitors’ native language, they voiced concerns about the risk of reducing language-learning opportunities: *“Trouble is... people need to overcome that. People need to actually just learn to fill those forms themselves. The drop-in is supposed to support that, rather than take it away”*. In a related manner, they described many interactions as a “pretext to engage”, meaning that automating tasks might erode opportunities for relationship-building.

Despite these reservations, staff suggested alternative roles for the robot, such as light-hearted engagement and signposting: *“I would put it somewhere with like a fun little box... Teach me a fun fact, teach me a word”* and *“It could be really useful for some basic signposting... Where can I get free clothes? The robot can tell them and give directions”*. They emphasized that any deployment should be limited and accurate: *“It needs very specific tasks where the information is accurate... Start with something simple like free clothes or bikes”*. Practical recommendations included a menu-driven interface, multilingual capability (“It would have to have Arabic, Farsi, Sorani, and Ukrainian at least”). Importantly, staff highlighted a structural gap in community information: *“There’s so much knowledge in the community, but it’s never in one place... issue by issue, what you can get where”* suggesting the robot could help centralize and disseminate vetted local knowledge.

This discussion directly informed **RQ2b**, revealing both the limits and possibilities of integration. While initial reactions were cautious, the conversation evolved toward practical suggestions. The first proposed task was automatic registration for ESOL courses; however, this proved infeasible due to data sensitivity and lack of cooperation from colleges. When ESOL registration proved infeasible, the discussion shifted toward other opportunities for technical guidance. A second iteration focused on guiding users through technical steps for a bike voucher scheme, such as downloading the app, locking or unlocking the bike, etc., but this collaboration ended before implementation due to time constraints and voucher shortages.

Following these setbacks, we worked with staff to identify alternative applications aligned with their priorities. A key issue was limited access to reliable information. In response, we configured the robot to provide details about local services, including food hubs offering free or discounted groceries, supported by online resources and location maps. These tasks, proposed and refined with staff input, directly addressed **RQ1c**, revealing both the complexity of service

navigation and the potential for technology to complement, and not replace, human support.

### **5.4.5 Discussion & Conclusions**

Observations during deployment in the multicultural center highlight how linguistic and cultural factors, combined with varying attitudes toward robots, shaped engagement. While some visitors were hesitant to interact, others expressed enthusiasm for the concept and a desire for broader availability, with one remarking: “I wish we had more robots that can help us and that are friendly”. This underscores a generally positive attitude toward social robots as supportive tools in community settings. Similar to the behavior observed among students in university support services (Section 4.4.2), the robot attracted attention in the multicultural center, though engagement was not universal.

Despite the small sample, a key finding is the strong alignment between the Student Lab & In-The-Wild studies: user satisfaction with the multilingual system remained consistent across contexts.

Discussions with CWIN charity staff revealed both enthusiasm and caution. Regarding the robot speaking in RAS visitors’ native language, staff expressed concerns about potentially reducing language-learning opportunities. Despite these reservations, they suggested alternative roles for the robot, such as light-hearted engagement and signposting, while emphasizing that any deployment should be limited and accurate: “It needs very specific tasks where the information is accurate... Start with something simple like free clothes or bikes.”

In conclusion, this study deployed a bilingual support robot in different spaces and activities, including the drop-in service, and observed interactions between RAS visitors and the robot. Much of the work focused on identifying suitable tasks for a pilot version and building trust and collaboration with charity staff. Given the small sample, findings are exploratory, and further research is needed to validate these insights and examine language preferences more systematically.

## **5.5 Chapter Conclusions**

This chapter examined refugees and asylum seekers (RAS) at the multicultural center, where the Scottish CWIN charity operates, focusing on native speakers of Arabic. We evaluated the bilingual support robot through two complementary approaches: (1) a participatory design study with Syrian RAS, and (2) an in-the-wild deployment at a drop-in service supporting displaced people. Together, these studies aimed to address our research questions.

**RQ1) Which services do newcomers need, and how do they currently access them?**

More specifically:

**RQ1b) Which services do Syrian RAS need, and how do they currently access them?**

Focus group discussions directly addressed the services Syrian refugees access and the ways they currently navigate them. These conversations revealed that ESOL registration and access to healthcare are among the most critical needs. Participants also emphasized the importance of a reliable source of official information, ideally through a unified platform. The results also agree with previous research carried out in different host countries on the needs and challenges faced by RAS (e.g., [180, 182]), which is relevant to this group in Scotland.

**RQ1c) Which services do RAS need, and how do they currently access them?**

Currently, RAS rely on the Scottish CWIN charity, among other organizations, which offers a range of activities and a weekly drop-in service providing support and advice on ESOL registration, bike rentals, free SIM cards, and general assistance. The charity also signposts visitors to other organizations in the city when needed.

Regarding services where the bilingual robot could add value, staff identified three priorities during discussions. The first was automatic registration for ESOL courses, which mirrored the insights from the Syrian focus groups and reflected the importance of language learning for newcomers. The second was assistance with bike rentals, a practical need given that public transportation in the city is not free for RAS and cycling remains one of the few cost-free travel options. Finally, to address one of the barriers highlighted by Syrian participants, the lack of reliable information sources, the robot was programmed to provide accurate details about local resources such as libraries and food hubs. These suggestions illustrate how staff envisioned the robot as a tool for practical, high-confidence tasks that could complement existing support services.

**RQ2b) To what extent are human support services for RAS willing to integrate social robots into their offerings?**

Initially, CWIN charity staff did not view the robot as a bureaucracy navigator but rather as a potential teaching utility, and they suggested alternative roles for it while agreeing only to a time-limited deployment. Later in the meeting, however, they recognized the value of automating certain tasks, given their heavy reliance on volunteers. They proposed tasks where they needed additional support, such as ESOL registration and guiding users through the technical steps involved in bike rentals across the city. For another task, providing information about food hubs and libraries, they explained

that they lacked the time to sit down with each RAS visitor and show them these resources, even though they wanted to offer this service. After observing the robot deployed in other spaces and seeing visitors' reactions, staff agreed that it could be integrated into the drop-in service, overcoming initial concerns that it might interfere with existing activities.

**RQ3) Do newcomers prefer accessing services in their native language, even when provided by a robot?**

More specifically:

**RQ3b) Do Syrian RAS prefer accessing services in their native language, even when these services are provided by a robot, and how does the robot's appearance (e.g., perceived gender and religious attire) influence this preference?**

In the fourth theme identified after the robot demonstration, *Exploring Potential Support Solutions* (Section 5.3.2), participants expressed positive attitudes toward using the robot as a complement to existing services delivered in their native language. They indicated they would willingly use a robot regardless of its gender or religious appearance.

**RQ3c) Do RAS prefer accessing services in their native language, even when these services are provided by a robot?**

Overall, task feedback and SASSI responses were aligned with results from the Student Lab & In-The-Wild studies. While these findings suggest that the bilingual system was easy to use and generally well-received, they do not directly indicate a strong preference for native language interaction, as only two out of seven participants conversed in their native language, Arabic. This highlights that positive usability perceptions may stem from the system's overall design rather than language matching alone. Further investigation with a larger sample and more native-language interactions is needed. Given the small sample size ( $n = 7$ ), these findings should be considered exploratory.

**RQ4) Does observing the robot in action lead Syrian RAS to hold more positive attitudes towards using it to access services?**

In the Refugee Co-Design Study, participants in each focus group completed the Arabic version of the Negative Attitude toward Robots Scale (NARS) [196] questionnaire (Fig. C.1 in the appendix), a widely used measure of robot acceptability. They did so twice, once before observing the robot in action and once after, when the robot

appeared in different attires (e.g., a wig and a hijab). Participants' overall attitudes toward the robot ranged from neutral to positive. Observing the robot interacting with the interviewer in Arabic and English did not significantly change these attitudes. With this very small data sample, we were unable to find quantitative evidence to address this question.

In summary, this chapter provided exploratory insights into the potential role of multilingual social robots in supporting refugees and asylum seekers. It represents the first co-design process with RAS for a social robot aimed at addressing bureaucratic needs, marking an important step toward inclusive technology design. Across both studies, we observed that language accessibility and automation can help address practical barriers, but their impact depends on careful integration with existing human services and trust-building with stakeholders. The findings suggest that social robots can complement, rather than replace, community support, particularly for high-confidence, well-defined tasks. However, the small sample size and limited native-language interactions mean these results should be interpreted cautiously. Future work should involve larger participant groups, and systematic evaluation of language preferences to determine how such technologies can best enhance inclusivity and access to essential services.

# Chapter 6

## Guidelines to Robot Deployment in Public Service Spaces

### 6.1 Chapter Introduction

Building on Mintrom et al.’s definition of *Public Spaces* as “anywhere that groups of people who may or may not know each other can freely assemble, move about, and interact” [119], and on the European Parliament’s definition of a *Public Service* as “an economic activity of general interest defined, created and controlled by the public authorities and subject, to varying degrees, to a special legal regime, irrespective of whether it is actually carried out by a public or private body” [202], we define a *Public Service Space* as a publicly accessible environment where people can freely assemble, move about, and interact while accessing services of general interest that are defined, overseen, or guaranteed by public authorities, even when those services are delivered by private or third-sector providers.

Deploying a robot in a public space, and especially in a public service space, typically involves integrating it into an existing workplace. This process requires consultation with multiple stakeholders, including management, visitors, and front-line workers, to define the details of the system. To frame the dynamics observed in the public robot deployments, we draw on the stakeholder framework introduced in Section 2.4, which categorizes actors based on their level of power and interest in the deployment. The framework uses a matrix with two dimensions: influence (power) and attention (interest). Stakeholders fall into four groups: (1) *Key Players*, such as front-line workers and main users, who have high power and high interest; (2) *Sleeping Giants*, such as managers, who hold significant power but may show limited day-to-day interest; (3) *Gadflies*, individuals who can mobilize or influence key players despite having less formal power; and (4) *Irrelevants*, those with minimal influence or interest, such as casual visitors. This categorization helps explain why managers’ approval was essential for deployment, while front-line staff engagement determined its practical success.

This chapter synthesizes findings from deployments of multilingual social robots in two public service space: (1) a university student services center and (2) a refugees and asylum seekers (RAS) drop-in service (Figure 6.1). Rather than presenting these cases separately, the chapter extracts cross-cutting lessons concerning organizational, social, and practical challenges in real-world deployment. Based on these insights, we then propose a set of actionable guidelines for future implementations in public service spaces, and conclude with a summary of key contributions.

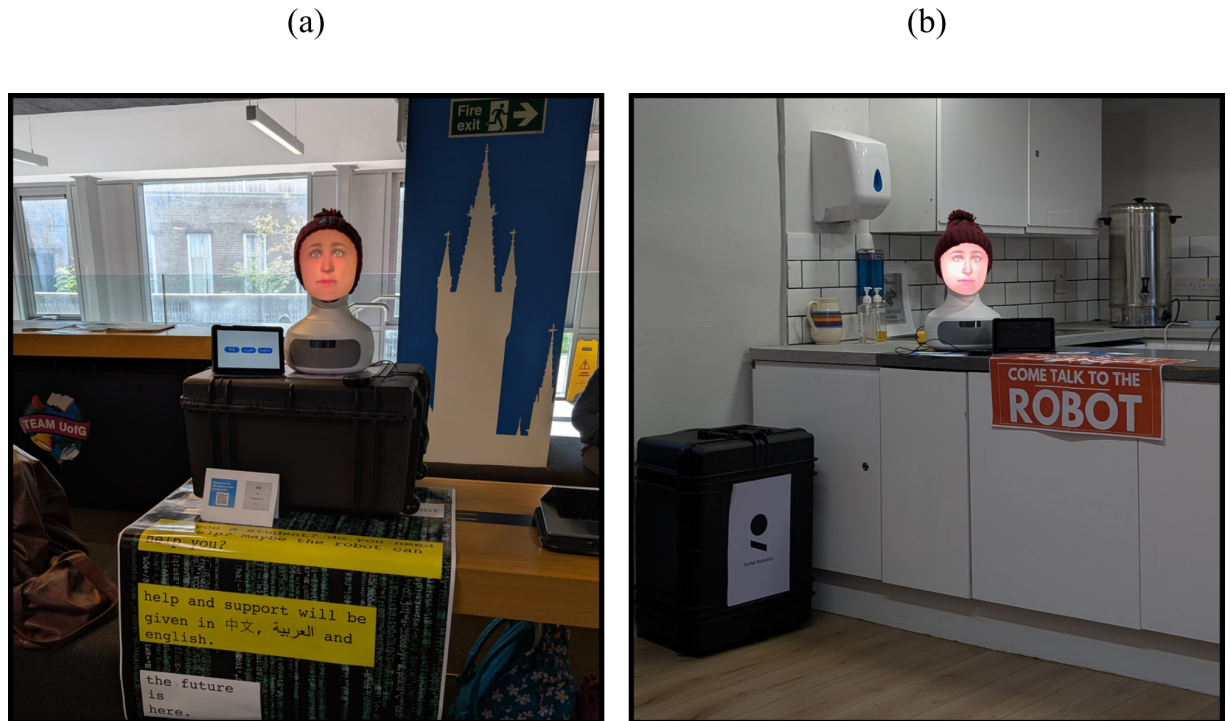


Figure 6.1: Public service spaces: (a) a student services center and (b) a RAS drop-in service

## 6.2 Lessons Learned from Deployments

Drawing on deployments in both the student services center and the RAS drop-in service, we extract a set of cross-cutting lessons that reflect organizational, social, and practical challenges encountered when introducing social robots into public service spaces. These lessons are presented thematically, drawing on the stakeholder framework as an interpretive lens for understanding how different actors shaped deployment outcomes.

### 6.2.1 Organizational Barriers and Institutional Dynamics

Deployment outcomes were strongly influenced by stakeholders with high decision-making authority, particularly those classified as *Sleeping Giants*. In the student services context, frequent

changes in management led to repeated renegotiation of approval, demonstrating how limited day-to-day engagement combined with high power can disrupt continuity. Without sustained involvement of these stakeholders, prior agreements were rendered invalid, delaying deployment progress.

In contrast, the RAS drop-in service, a smaller organization, exhibited greater operational flexibility. Here, stakeholders often held overlapping roles, with managers acting simultaneously as *Key Players* due to their direct involvement in daily work. While this structure reduced bureaucratic barriers, it increased reliance on trust and informal agreement rather than formal processes.

These cases illustrate that deployment strategies must account for the organizational position of *Sleeping Giants* and *Key Players*, adapting engagement approaches depending on whether authority is centralized or distributed.

### **6.2.2 Stakeholder Engagement and Informal Influence**

Successful deployment depended not only on formal approval but also on active engagement from *Key Players* and *Gadflies*. Front-line staff, as *Key Players*, were essential in shaping how the robot was integrated into existing workflows and ensuring its relevance to user needs. Their daily interaction with service users positioned them as central actors in determining practical success.

Equally important were *Gadflies*, individuals with lower formal authority but significant influence. These stakeholders acted as internal advocates, facilitating communication between *Sleeping Giants* and *Key Players*, maintaining momentum during periods of uncertainty, and helping to build trust in the system.

In both deployments, *Gadflies* played a critical role in overcoming delays caused by managerial turnover and organizational hesitation, highlighting the importance of informal influence networks alongside formal authority structures.

### **6.2.3 Trust, Robophobia, and Technology Acceptance**

Across both contexts, initial resistance to deployment was driven primarily by social concerns rather than technical limitations. *Sleeping Giants* expressed uncertainty about the robot's impact on service delivery, while *Key Players* were concerned about potential disruptions to their workload and interactions with users.

This resistance was consistently mitigated through direct exposure to the robot. Live demonstrations allowed stakeholders to observe the system in practice, reducing uncertainty and reshaping perceptions. In particular, hands-on interaction enabled *Sleeping Giants* to better understand the scope and limitations of the system, while helping *Key Players* evaluate its practical utility.

In the student services deployment, this was achieved through online meetings in which videos of the robot and its potential dialogues were presented to staff (Fig. D.1). In the RAS deployment, printed materials illustrating the robot and its planned interactions were distributed to stakeholders based on prior experience that early exposure helped reduce uncertainty (Fig. D.2).

## 6.2.4 Task Definition and Feasibility Constraints

The process of identifying suitable tasks for the robot revealed tensions between stakeholder expectations and system feasibility. In the drop-in use case, *Key Players* and *Sleeping Giants* proposed a range of potential tasks, including ESOL course registration and integration with external services. However, many of these proposals proved infeasible due to technical limitations, lack of data access, or institutional constraints.

Additionally, some external actors, categorized as *Irrelevants* in terms of deployment authority, shaped early task ideas (e.g., third-party service providers), even though they did not directly participate in implementation decisions. Their influence highlights how ideas can originate outside core stakeholder groups, even if they are not ultimately actionable.

As a result, tasks were iteratively refined toward simpler, high-confidence functionalities that could be reliably delivered within existing constraints. This demonstrates that effective deployment requires balancing stakeholder expectations with realistic operational feasibility.

## 6.3 Guidelines for Future Deployments

Building on the lessons identified in Section 6.2, we propose a set of practical guidelines for deploying social robots in public service spaces. These guidelines translate empirical findings into actionable recommendations for researchers, designers, and practitioners working in real-world environments. They are organized into two complementary dimensions: (1) organizational and deployment considerations, and (2) user-centered design and inclusivity considerations.

### 6.3.1 Organizational and Deployment Guidelines

#### Actively Engage Decision-Makers Throughout the Deployment Process

Stakeholders with high decision-making power, such as *Sleeping Giants*, can significantly influence whether a deployment succeeds or fails. Because these stakeholders may not be involved in day-to-day activities, their lack of continuous engagement can lead to delays, misunderstandings, or withdrawal of support.

To mitigate this, researchers should maintain regular communication with decision-makers, revisit agreements when organizational changes occur, and ensure that project goals remain aligned with institutional priorities throughout the deployment process.

### **Involve Front-Line Staff Early and Continuously**

*Key Players*, such as front-line workers, are essential to the practical success of a deployment. These stakeholders interact directly with users and understand real service needs, making their input critical for defining relevant tasks and ensuring usability.

Front-line staff should be involved from the early stages of design and remain engaged throughout deployment. Their feedback should inform both system functionality and integration into existing workflows.

### **Identify and Support Internal Advocates**

Informal stakeholders, or *Gadflies*, play a key role in maintaining momentum and facilitating communication within organizations. These individuals often act as intermediaries between decision-makers and operational staff, helping to sustain projects during periods of uncertainty or resistance.

Researchers should identify these stakeholders early and actively support their involvement, as their advocacy can be crucial for overcoming institutional barriers and ensuring continuity.

These individuals can often be identified through their visible engagement and their tendency to facilitate communication across teams. They can be supported by keeping them informed and involving them in key moments of the project.

### **Use Live Demonstrations to Build Trust and Reduce Resistance**

Initial resistance to social robots is often driven by uncertainty and perceived disruption rather than technical limitations. Both *Sleeping Giants* and *Key Players* may hold concerns about how the system will affect existing workflows and interactions. These reactions align with what has been described in the literature as *Robophobia*, referring to social hesitation or resistance toward forming interactions with robotic systems [203]. They are also related to earlier work on *robot anxiety*, which captures emotional responses that hinder human-robot interaction [196].

Conducting live demonstrations early in the process allows stakeholders to observe the system in action, understand its capabilities and limitations, and reframe it as a supportive tool. Hands-on interaction is particularly effective in reducing skepticism and building trust.

### **Start with Simple, High-Confidence Tasks**

Stakeholders often propose ambitious use cases, such as full automation of bureaucratic processes or integration with external systems. However, these tasks may be infeasible due to technical constraints, data access limitations, or organizational barriers.

Deployments should therefore begin with simple, well-defined tasks that can be delivered reliably. Starting small allows the system to demonstrate value quickly and creates a foundation for future expansion.

### **Align System Capabilities with Organizational Constraints**

Successful deployment requires balancing stakeholder expectations with practical feasibility. Constraints may include data access, institutional policies, and available resources, as well as limitations imposed by external actors (*Irrelevants*) who influence ideas but do not control implementation.

Researchers should carefully evaluate which tasks are both useful and achievable within these constraints, for example by defining a limited set of core functionalities early on and reviewing them with stakeholders before development, and communicate these limitations clearly from the outset.

## **6.3.2 User-Centered Design and Inclusivity Guidelines**

### **Prioritize Functional Language Needs in Multilingual Design**

Mastering an additional language is not always associated with privilege. To account for this, we distinguish between *elite* and *folk* bilingualism. *Elite* bilinguals acquire a high-status second language (L2) alongside their dominant first language (L1), often facilitating access to social and institutional resources. In contrast, *folk* bilinguals learn the dominant language as an L2 out of necessity, while their L1 is of lower social status. For them, proficiency in L2 is not optional but essential, since lacking host-language skills can obstruct everyday functioning [204, 205, 206].

This distinction has direct implications for social robot deployment. Multilingual systems should prioritize functional support for *folk bilinguals*, who rely on L2 for everyday survival, rather than focusing on prestige-driven language use. For this reason, Arabic, Sorani Kurdish, and Farsi were identified as relevant languages in the RAS deployment, based on input from CWIN staff and participants in the focus groups.

Designers should therefore select languages based on real user needs and service accessibility, rather than technological convenience or perceived global importance.

### **Account for Technical Limitations in Under-Resourced Languages**

Supporting multiple languages in social robot systems introduces practical challenges, particularly for under-resourced languages. In our case, plans to deploy the robot in Sorani Kurdish and Persian were not realized due to limitations in available speech recognition and synthesis technologies.

Kurdish, spoken by over 35 million people, includes several dialects such as Sorani and Kurmanji, but language technology for Kurdish remains limited [207, 208]. Persian (Farsi), spoken by over 110 million people, has more developed language resources, but the available speech synthesis on the robot lacked sufficient quality and lip-sync capabilities for deployment.

In contrast, Arabic represents a high-resource language with strong support in current AI systems, making it the most feasible option for deployment among the languages identified by stakeholders.

These constraints highlight the need to balance user needs with technological feasibility. Designers should prioritize languages that maximize accessibility while acknowledging system limitations, and explore alternative interaction strategies when full language support is not possible.

### **Design for Diverse, Non-WEIRD User Populations**

Most HRI research is conducted with participants from so-called “WEIRD” (Western, Educated, Industrialized, Rich, and Democratic) societies, meaning that systems are typically designed for users familiar with Anglo-centered communication norms [150, 209]. A systematic review of HRI studies from 2006 to 2022 confirms that participant samples overwhelmingly come from WEIRD populations, and highlights a persistent lack of reporting on race, ethnicity, and cultural identity [210].

This bias has direct implications for system design. Social robots deployed in public service spaces often serve users with diverse linguistic, cultural, and social backgrounds, whose needs may differ significantly from those represented in WEIRD datasets. Recent work also highlights structural imbalances in HRI research, with influence concentrated in Europe and North America, raising concerns about whose perspectives shape the field’s design practices [211].

Designers should therefore avoid assuming familiarity with dominant communication norms and instead prioritize inclusivity. This includes supporting diverse cultural practices, accommodating varying levels of literacy and language proficiency, and validating design decisions with target populations rather than relying on assumptions derived from WEIRD contexts.

### **Support the Development of Inclusive HRI Research and Practice**

The HRI research community has begun to acknowledge the limitations of WEIRD-centered research and is actively working to address them. This is reflected in the emergence of dedicated workshops and initiatives focusing on diversity, equity, and inclusion in HRI, including work on gender, children, older adults, and underserved populations [212, 213, 214, 215].

In this context, targeted initiatives focusing on refugees, asylum seekers, and migrants are particularly important. For example, the “*Robots and Autonomous Systems for Refugees, Asylum Seekers, and Migrants (RAS4RASM)*” workshop, organized in 2025 by the researcher and collaborators, aimed to foster a research community dedicated to these populations.

Researchers should actively contribute to such efforts, ensuring that future HRI research reflects the needs of diverse and underrepresented user groups. Building a more inclusive research ecosystem is essential for developing socially intelligent robots that serve global populations rather than reinforcing existing biases.

### **Prioritize Community Needs and Address Power Imbalances**

Deploying social robots in humanitarian contexts raises important ethical considerations, particularly when working with refugees and asylum seekers (RAS). As highlighted by Leal et al., tensions can arise between the roles of *researcher* and *activist*, especially when projects risk prioritizing academic objectives over community needs [216].

Researchers must remain mindful that RAS participants, who may face significant structural and educational barriers, are contributing to projects that primarily advance academic goals. This creates an inherent power imbalance that must be acknowledged and addressed.

Community needs should therefore take precedence over researcher-driven agendas. When participants express specific priorities such as improving access to information or services these should not be overridden in favor of technically driven or academically motivated objectives.

Researchers should also carefully consider their level of involvement. While maintaining objectivity is important, deeper engagement through participatory or ethnographic approaches can help foster trust, cultural sensitivity, and more meaningful outcomes.

### **Avoid Short-Term Engagement and Commit to Long-Term Impact**

It is important to avoid the “smash-and-grab” approach, where researchers engage briefly to collect data and then disengage, as this is both ethically problematic and unlikely to produce meaningful outcomes [154]. Instead, researchers should aim for sustained engagement with communities, building trust over time through continued interaction.

One way to achieve this is through deeper involvement, such as volunteering with local organizations or contributing to community-driven initiatives. In our case, this approach enabled a closer understanding of service practices and user needs while supporting trust-building with stakeholders.

Researchers should also ensure that projects provide tangible benefits beyond data collection. For example, when the project and volunteer work at the CWIN charity had finished, the researcher provided the organization with all resources created during the project. These included information about food hubs and libraries relevant to each neighborhood in Glasgow (Fig. D.3).

Researchers should seek opportunities to contribute beyond data collection. Volunteering and resource sharing can help ensure that projects leave a positive and lasting impact on the communities involved.

## **6.4 Chapter Conclusions**

This chapter synthesized lessons learned from deploying social robots in public service spaces, highlighting that successful implementation depends not only on technical capability but also on

organizational dynamics, stakeholder engagement, and user-centered design. Across both deployments, it became clear that the process of integrating robotic systems into existing services requires navigating institutional constraints, building trust among stakeholders, and aligning system functionality with real-world needs.

The findings demonstrate that deployment is shaped by both organizational and user-centered factors. On the one hand, engagement with stakeholders (e.g., decision-makers, front-line staff, and informal advocates) is critical for overcoming institutional barriers and ensuring continuity. On the other hand, effective system design must account for the diverse needs of users, including language accessibility, cultural variation, and unequal access to services.

Based on these insights, this chapter proposed a set of practical guidelines for future deployments, structured around these two complementary dimensions. Together, these guidelines provide a framework for designing and implementing social robots that are not only technically functional, but also socially and organizationally viable.

Ultimately, this work shows that deploying social robots in public service spaces requires prioritizing the *human* aspects of Human-Robot Interaction. Future efforts should continue to advance inclusive, multilingual technologies while fostering ethical, sustained engagement with the communities they are intended to support, ensuring that such systems contribute to reducing barriers rather than reinforcing existing inequalities.

# Chapter 7

## Conclusions

### 7.1 Summary of Main Findings

This thesis addresses three primary research questions using a mixed-methods approach, including interviews, surveys, and user studies, to examine newcomer needs and the role of social robots in public service contexts. In addition, a fourth research question emerged while designing the Refugee Co-Design Study, a fourth question emerged.

**RQ1** Which services do newcomers need, and how do they currently access them?

**RQ2** To what extent are human support services willing to integrate social robots into their offerings?

**RQ3** Do newcomers prefer accessing services in their native language, even when provided by a robot?

**RQ4** Does observing the robot in action lead Syrian Refugees and Asylum Seekers (RAS) to hold more positive attitudes towards using it to access services?

These questions were examined in two distinct newcomer populations in Scotland: (1) international students and (2) RAS. Each question was contextualized for the respective public service spaces: (1) the student support center and (2) a drop-in service for RAS, to capture a comprehensive view of newcomer needs and support mechanisms.

#### 7.1.1 RQ1: Newcomer Service Needs and Access

Across both populations, access to reliable information emerged as a central challenge. International students required support with practical tasks such as navigating institutional procedures and accessing administrative services, while RAS participants faced additional barriers related to language, fragmented service provision, and limited access to official information.

These findings show that newcomers rely on external support systems to navigate complex bureaucratic environments, and highlight the importance of centralized, accessible information as a key design requirement for support technologies.

### **7.1.2 RQ2: Stakeholder Acceptance of Social Robots**

Stakeholders across both contexts were generally open to integrating social robots, provided that they complemented rather than replaced human services. Initial skepticism was often observed, particularly among decision-makers and service staff, but attitudes became more positive following demonstrations and opportunities to interact with the system.

These results indicate that perceived usefulness, alignment with organizational goals, and direct exposure to the technology are critical factors in stakeholder acceptance.

### **7.1.3 RQ3: Preference for Native-Language Interaction**

Language accessibility was found to significantly influence usability and user satisfaction. International students consistently preferred interacting with the robot in their native language and demonstrated improved task performance. RAS participants also expressed positive attitudes toward multilingual support, although their engagement was constrained by the limited language options available.

Together, these findings suggest that language access is not merely a preference but a functional requirement in public service contexts, particularly for users navigating unfamiliar systems.

### **7.1.4 RQ4: Attitudes Toward Robots**

Overall, RAS participants exhibited neutral to positive attitudes toward robots. Observing the robot in action did not significantly change these attitudes, although qualitative feedback indicated increased comfort and openness following interaction. Due to the small sample size, these findings should be interpreted as exploratory.

Nonetheless, the findings suggest that direct interaction may help reduce uncertainty and support acceptance, even if measurable attitude change is limited.

## **7.2 Key Insights**

Building on the findings summarized by the research questions and the lessons identified in Chapter 6, this thesis highlights several cross-cutting insights that advance understanding of how social robots can be designed and deployed in public service contexts.

### **7.2.1 Information Access Is the Primary Value of Social Robots in Public Services**

Across all studies, the central value of the robot was its ability to provide timely, reliable, and actionable information. Both international students and RAS participants sought assistance with navigating services, accessing resources, and understanding bureaucratic procedures. This indicates that, in public service environments, social robots are most effective when positioned as tools for reducing informational barriers, rather than as conversational or socially expressive agents. This reframes the role of social robots in HRI, suggesting that their value in such contexts lies less in social engagement and more in their ability to provide reliable and accessible information.

### **7.2.2 Language Support Is a Functional Requirement Rather Than a Preference**

Findings across populations show that multilingual support is not merely a usability enhancement but a fundamental requirement for equitable access to services. International students consistently preferred interacting in their native language and demonstrated improved task performance, while RAS participants highlighted the importance of accessing information in languages they fully understand.

This supports a shift from viewing multilingual interaction as optional to recognizing it as essential, particularly for *folk bilinguals* who rely on language access to navigate everyday institutional processes. More broadly, it highlights the need to reconsider how language is treated in HRI design, moving from a usability feature toward a core requirement for equitable access.

### **7.2.3 Social Robots Complement Rather Than Replace Existing Services**

Stakeholders across both contexts consistently emphasized that robots should augment, rather than replace, human support. While robots were considered valuable for handling repetitive, information-driven tasks, human staff remained essential for complex, sensitive, and context-dependent interactions.

This insight highlights the importance of designing hybrid service models, where robots are integrated into existing ecosystems to improve efficiency while maintaining human-centered support structures. It also challenges common narratives in HRI that position robots as replacements for human labor, instead reinforcing their role as supportive tools within established service systems.

### **7.2.4 Organizational Context Determines Deployment Feasibility**

The deployment process was shaped as much by organizational structure as by technical capability. In large institutions, hierarchical decision-making and managerial turnover created barriers that required ongoing negotiation and stakeholder engagement. In contrast, smaller community organizations relied more heavily on trust, informal communication, and prior relationships.

These findings demonstrate that successful deployment depends on understanding and adapting to the organizational environment, including the roles and influence of different stakeholders. This suggests that technical readiness alone is insufficient, and that deployment strategies must account for institutional dynamics as a core design consideration.

### **7.2.5 Trust and Direct Exposure Shape Acceptance of Social Robots**

Initial stakeholder reactions to the robot were often characterized by uncertainty and skepticism, driven primarily by perceived disruption rather than technical concerns. However, exposure to the robot through live demonstrations and hands-on interaction significantly improved acceptance.

This suggests that familiarity and experience play a critical role in shaping perceptions of social robots, and that acceptance is not fixed but can be actively influenced through design and deployment practices. This reinforces the importance of incorporating demonstration and stakeholder engagement into the deployment process, rather than treating acceptance as a passive outcome.

### **7.2.6 Effective Deployment Requires Balancing User Needs with Practical Constraints**

Finally, the thesis demonstrated that successful implementation requires balancing user-centered design with organizational and technical constraints. While stakeholders and users often proposed ambitious functionalities, many were not feasible due to limitations in data access, system capabilities, or institutional integration.

As a result, effective deployments focused on well-defined, achievable tasks that addressed high-priority needs. This highlights the importance of iterative design, realistic scoping, and continuous alignment between expectations and feasibility. More generally, it suggests that successful HRI deployments require balancing user needs with institutional and technical constraints, rather than prioritizing one dimension over the others.

## 7.3 Contributions

This thesis makes five main contributions to Human-Robot Interaction (HRI) research and practice. These contributions build on the studies presented throughout the thesis and are synthesized here to reflect their broader implications.

### 7.3.1 Advancing Multilingual HRI in Bureaucratic Support Contexts

This research advances HRI by demonstrating how social robots can support users in navigating bureaucratic processes, a context that has received limited attention in prior work. Across both student and RAS deployments, the findings show that language barriers and procedural complexity are central challenges in accessing public services, and that robots can play a role in reducing these barriers.

The work shows that multilingual capabilities, combined with structured information delivery, can improve accessibility while supporting existing service providers. Importantly, it demonstrates that such systems can act not only as functional tools, but also as visible signals of institutional support in high-stress environments.

### 7.3.2 Co-Design with Refugees and Asylum Seekers (RAS)

This thesis contributes the first co-design process of a social robot specifically targeting bureaucratic support for RAS. Through participatory design methods and qualitative analysis, it demonstrates that RAS participants face well-documented challenges in accessing services, while also showing openness to robot-mediated support.

The work provides an example of how co-design can be conducted with underserved populations in a way that is both ethically grounded and practically informed, ensuring that system design reflects real user needs.

### 7.3.3 Deployment of a Bilingual Support Robot for RAS

This thesis demonstrates the deployment of a bilingual social robot designed to support RAS in navigating bureaucratic processes. Building on insights from co-design sessions and stakeholder engagement, the system was implemented and evaluated in a real-world community setting.

To the best of the researcher's knowledge, this represents the first deployment of a bilingual social robot specifically developed for bureaucratic support of RAS. Similar to the student support deployment, the system was integrated into an existing service environment (the CWIN drop-in center), demonstrating both feasibility and acceptability in a community context.

These findings show that bilingual robots can provide practical assistance in real-world settings, supporting users in accessing services while complementing existing human support structures.

### **7.3.4 Guidelines for Deploying Social Robots in Public Service Spaces**

Building on these deployments, the thesis proposes a set of practical guidelines for implementing social robots in public service contexts. These guidelines synthesize lessons across multiple studies and address both organizational and user-centered challenges, including stakeholder engagement, trust-building, task feasibility, multilingual design, and ethical considerations.

Together, they provide a transferable framework for deploying social robots in complex real-world environments, emphasizing that successful implementation depends on aligning technical capabilities with organizational dynamics and user needs.

### **7.3.5 Application of Stakeholder Analysis in HRI Deployment Contexts**

This thesis applies a stakeholder analysis framework based on Newcombe’s model to examine how organizational roles and power dynamics shape the deployment of social robots in public service spaces. By differentiating between stakeholder types such as *Key Players*, *Sleeping Giants*, *Gadflies*, and *Irrelevants*, the work demonstrates how these actors influence system adoption, deployment continuity, and practical success.

To the best of the researcher’s knowledge, this research represents the first application of Newcombe’s stakeholder framework for a comprehensive analysis of social robot deployment in public service environments. While prior work has examined stakeholder perspectives in HRI and has applied the framework in other domains such as elderly care, this thesis extends its use to real-world service settings involving diverse user populations.

This contribution provides a structured approach for understanding the organizational dynamics that affect HRI deployments, highlighting the importance of both formal authority and informal influence in shaping outcomes.

## **7.4 Limitations and Future Directions**

While this thesis provides important insights into the design and deployment of social robots in public service contexts, it also highlights several directions for future research that extend beyond the scope of the current work.

### **7.4.1 Scaling Across Populations and Service Ecosystems**

The studies in this thesis were conducted with relatively small and context-specific populations, particularly in the RAS-focused work. While these provided rich qualitative insights that align with prior research, further investigation across more diverse populations and service environments is needed to understand how these findings extend to other contexts.

Future work should examine deployments across broader public service ecosystems, including healthcare access points, local government services, and community-based organizations in different geographic contexts. Expanding participant diversity in terms of language background, socio-economic status, and length of time in the host country would further contribute to a more comprehensive understanding of how social robots can support heterogeneous populations.

### **7.4.2 Expanding Language Support for Under-Resourced Languages**

Although the robot systems supported multiple languages, including Arabic and Mandarin Chinese, they were unable to accommodate several languages identified as critical by users and stakeholders, such as Sorani Kurdish and Persian. This limitation reflects broader challenges in speech recognition and synthesis technologies for under-resourced languages.

Future research should prioritize the development of more robust language technologies for these languages, alongside exploring alternative interaction strategies, such as multimodal interfaces, simplified dialogue structures, or hybrid human-robot support. These approaches may improve accessibility even in contexts where full language support remains technically constrained, enabling more inclusive systems at scale.

### **7.4.3 Long-Term Deployment and Organizational Integration**

The deployments conducted in this thesis primarily focused on short-term interactions and initial user and stakeholder responses. While these studies provided valuable insights into feasibility and early acceptance, they do not fully capture how social robots integrate into service environments over time.

Future work should investigate long-term deployments, examining how user engagement, trust, and perceived usefulness evolve with repeated use. In addition, longitudinal studies could explore how robots influence organizational practices, including staff workload, service efficiency, and patterns of user interaction, particularly when the technology becomes embedded within routine service delivery.

### **7.4.4 Strengthening Comparative Evaluation of Social Robot Systems**

The deployments in this thesis focused on feasibility, user acceptance, and integration into real-world service contexts, rather than controlled comparison with alternative support systems. While this approach enabled meaningful insights into how social robots function in practice, future research would benefit from incorporating explicit comparison conditions.

Comparative studies could evaluate robot-supported interactions against existing forms of support, such as human assistance, web-based information systems, or mobile applications. Such work would provide a deeper understanding of the specific advantages and limitations

of social robots, and help identify the contexts in which they offer meaningful improvements over existing solutions.

### **7.4.5 Advancing System Capabilities and Integration**

The systems developed in this thesis were intentionally constrained to ensure reliability and feasibility in real-world deployments. While this approach supported successful integration, it limited the range of services that could be provided.

Future work should explore deeper integration with external systems, including appointment scheduling platforms, official databases, and public service portals. Enhancing dialogue capabilities to support more complex, adaptive interactions may further extend the usefulness of social robots, particularly in navigating multi-step bureaucratic processes.

### **7.4.6 Summary**

Taken together, these directions emphasize that advancing social robots in public service contexts requires not only technical innovation, but also sustained attention to inclusivity, organizational integration, and ethical responsibility.

## **7.5 Concluding Remarks**

This thesis has explored how social robots can support newcomers in accessing services within public service contexts, demonstrating that their effectiveness depends not only on technical capability but also on organizational dynamics, language accessibility, and user-centered design. Across multiple studies and deployment settings, the findings highlight the importance of designing systems that reduce informational barriers, complement existing services, and adapt to diverse user needs.

By combining multilingual interaction, stakeholder-aware deployment strategies, and sustained community engagement, this work contributes to a broader understanding of how social robots can be meaningfully integrated into real-world environments. Ultimately, the thesis suggests that the future of Human-Robot Interaction in public services lies in developing inclusive, adaptable systems that prioritize both human needs and institutional realities.

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# Appendix A

## Supplementary material for Chapter 3

### A.1 SASSI statements used in the study

Number	SASSI Factor	Statement
1	Cognitive Demand	I felt confident using the system
2		I felt tense using the system
3		I felt calm using the system
4		A high level of concentration is required when using the system
5		The system is easy to use
6	Habitability	I sometimes wondered if I was using the right word
7		I always knew what to say to the system
8		I was not always sure what the system was doing
9		It is easy to lose track of where you are in an interaction with the system
10	Likeability	The system is useful
11		The system is pleasant
12		The system is friendly
13		I was able to recover easily from errors
14		I enjoyed using the system
15		It is clear how to speak to the system
16		It is easy to learn to use the system
17		I would use this system
18		I felt in control of the interaction with the system

Table A.1: SASSI statements used in the study

# Appendix B

## Supplementary material for Chapter 4

### B.1 Demographics

ID	Condition	Native Language	Gender	Age	Education	Robot Helpful?
1	1	Arabic	Woman	27	Postgraduate	Yes
2	1	Arabic	Woman	28	Postgraduate	Yes
3	1	Arabic	Woman	29	Postgraduate	Yes
4	1	Arabic	Woman	33	Postgraduate	Yes
5	1	Arabic	Woman	34	Postgraduate	Yes
6	1	Arabic	Woman	37	Postgraduate	Yes
7	1	Arabic	Woman	41	Postgraduate	Maybe
8	1	Arabic	Man	33	Postgraduate	Yes
9	1	Arabic	Man	40	Undergraduate	Yes
10	1	Mandarin	Woman	21	Postgraduate	Maybe
11	1	Mandarin	Woman	22	Postgraduate	Yes
12	1	Mandarin	Woman	22	Postgraduate	Yes
13	1	Mandarin	Woman	23	Postgraduate	Yes
14	1	Mandarin	Woman	23	Postgraduate	Yes
15	1	Mandarin	Woman	24	Postgraduate	Maybe
16	1	Mandarin	Woman	24	Postgraduate	Yes
17	1	Mandarin	Woman	25	Postgraduate	Maybe
18	1	Mandarin	Woman	26	Postgraduate	Yes
19	1	Mandarin	Woman	27	Postgraduate	Yes
20	1	Mandarin	Woman	27	Postgraduate	Yes
21	1	Mandarin	Woman	27	Postgraduate	Maybe

Continued on next page

ID	Condition	Native Language	Gender	Age	Education	Robot Helpful?
22	1	Mandarin	Woman	29	Postgraduate	Yes
23	1	Mandarin	Woman	29	Postgraduate	Maybe
24	1	Mandarin	Woman	35	Postgraduate	Yes
25	1	Mandarin	Man	22	Postgraduate	Yes
26	1	Mandarin	Man	22	Postgraduate	Yes
27	1	Mandarin	Man	23	Postgraduate	Yes
28	1	Mandarin	Man	23	Postgraduate	Yes
29	1	Mandarin	Man	23	Postgraduate	Yes
30	1	Mandarin	Man	23	Postgraduate	Yes
31	1	Mandarin	Man	24	Postgraduate	Yes
32	2	Arabic	Woman	22	Postgraduate	Yes
33	2	Arabic	Woman	28	Postgraduate	Maybe
34	2	Arabic	Woman	32	Postgraduate	Maybe
35	2	Arabic	Woman	32	Postgraduate	Maybe
36	2	Arabic	Woman	35	Postgraduate	Maybe
37	2	Arabic	Woman	36	Postgraduate	Maybe
38	2	Arabic	Woman	38	Postgraduate	Yes
39	2	Arabic	Man	35	Postgraduate	Maybe
40	2	Mandarin	Woman	22	Postgraduate	Yes
41	2	Mandarin	Woman	22	Postgraduate	Yes
42	2	Mandarin	Woman	22	Postgraduate	Yes
43	2	Mandarin	Woman	22	Postgraduate	Maybe
44	2	Mandarin	Woman	23	Postgraduate	Yes
45	2	Mandarin	Woman	23	Undergraduate	Yes
46	2	Mandarin	Woman	23	Postgraduate	Yes
47	2	Mandarin	Woman	23	Postgraduate	Yes
48	2	Mandarin	Woman	24	Postgraduate	Yes
49	2	Mandarin	Woman	24	Postgraduate	Yes
50	2	Mandarin	Woman	28	Postgraduate	Yes
51	2	Mandarin	Woman	29	Postgraduate	Yes
52	2	Mandarin	Woman	31	Postgraduate	Yes
53	2	Mandarin	Woman	35	Postgraduate	Yes
54	2	Mandarin	Man	23	Postgraduate	Yes
55	2	Mandarin	Man	23	Postgraduate	Yes

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ID	Condition	Native Language	Gender	Age	Education	Robot Helpful?
56	2	Mandarin	Man	23	Postgraduate	Yes
57	2	Mandarin	Man	24	Postgraduate	Yes
58	2	Mandarin	Man	24	Postgraduate	Yes
59	2	Mandarin	Man	24	Postgraduate	Yes
60	2	Mandarin	Man	25	Postgraduate	Yes

Table B.1: Lab-Controlled Demographics

## B.2 In-the-Wild Demographics

ID	Native Language	Gender	Age	Education	Robot Helpful?
1	Arabic	Woman	28	Postgraduate	Yes
2	English	Woman	18	Undergraduate	Yes
3	English	Woman	21	Undergraduate	Yes
4	English	Woman	22	Postgraduate	Yes
5	English	Woman	22	Postgraduate	Yes
6	English	Woman	23	Undergraduate	Yes
7	English	Woman	25	Postgraduate	Yes
8	English	Woman	27	Postgraduate	No
9	English	Man	18	Undergraduate	Yes
10	English	Man	21	Undergraduate	Yes
11	English	Man	23	Postgraduate	Yes
12	English	Unreported	19	Undergraduate	Yes
13	English	Unreported	30	Postgraduate	Yes
14	English	Unreported	40	Undergraduate	Maybe
15	Mandarin	Woman	22	Postgraduate	Maybe
16	Mandarin	Woman	22	Postgraduate	Yes
17	Mandarin	Woman	23	Postgraduate	Yes
18	Mandarin	Woman	24	Postgraduate	Yes
19	Mandarin	Woman	24	Postgraduate	Yes
20	Mandarin	Woman	25	Postgraduate	No
21	Mandarin	Woman	28	Postgraduate	Yes
22	Mandarin	Man	21	Undergraduate	Maybe
23	Mandarin	Man	22	Postgraduate	Yes

Continued on next page

ID	Native Language	Gender	Age	Education	Robot Helpful?
24	Mandarin	Man	23	Undergraduate	No
25	Mandarin	Man	27	Postgraduate	Yes
26	Mandarin	Man	28	Postgraduate	Yes
27	Mandarin	Unreported	22	Undergraduate	Yes
28	Mandarin	Unreported	22	Postgraduate	Maybe
29	Mandarin	Unreported	26	Postgraduate	Maybe
30	Other	Woman	18	Undergraduate	Yes
31	Other	Man	23	Postgraduate	Yes
32	Other	Unreported	23	Undergraduate	Maybe

Table B.2: In-the-Wild Demographics

### B.3 Task cards used in the lab controlled study

Task	English	Chinese	Arabic
<b>1</b> Campus Directions	You ran into your advisor in the hall, and they told you they would like to meet you later in the JMS to discuss your project. You were so nervous you forgot to ask them how to get there.	你在走廊上遇到了你的导师，他们告诉你稍后在 JMS 与你见面讨论你的项目。你太紧张了，以至于忘记问他们怎么去那里。	لقد قابلت مستشارك في الممر وأخبرك بأنه يريد أن يقابلك لاحقًا في JMS لمناقشة مشروعك. كنت متوترًا جدًا لدرجة أنك نسيت أن تسأل عن كيفية الوصول إلى هناك.
<b>2</b> Local Tax Exemption	You live in Glasgow city centre. You got a letter this morning informing you of a £1000 debt for council tax. You remember there's something you can fill out in order to get a discount or not pay at all, but cannot remember what.	你住在格拉斯哥市中心。你今天早上收到了一封信，通知你欠下了1000英镑的市政税。你记得有一份表格可以填写以获得折扣或免除费用，但你记不起是什么了。	تعيش في وسط مدينة غلاسكو. لقد تلقيت هذا الصباح رسالة تخبرك بأن عليك دين قدره 1000 جنيه إسترليني لضريبة المجلس. تتذكر أن هناك شيئًا يمكنك ملؤه للحصول على خصم أو عدم الدفع على الإطلاق، لكن لا يمكنك تذكر ما هو.
<b>3</b> Financial Aid	Times are hard and you just got fired from your part time job, not to mention you're also a single parent. Maybe the university can help? Maybe there's a fund for struggling students?	日子艰难，你刚刚失去了兼职工作，更不用说你还是单亲家长。也许学校可以帮忙？也许有一个资助困难学生的基金？	الأوقات صعبة وقد تم فصلك للتو من وظيفتك الجزئية، ناهيك عن أنك أيضًا والد أعزب. ربما يمكن للجامعة أن تساعد؟ ربما هناك صندوق تمويل للطلاب الذين يعانون من صعوبات؟
<b>4</b> Official Documents	You're new to the UK, and you need to open a bank account, but the bank wants proof that you're enrolled in a UK university.	你刚到英国，需要开一个银行账户，但银行要求你提供你在英国大学注册的证明。	أنت جديد في المملكة المتحدة وتحتاج إلى فتح حساب بنكي، لكن البنك يريد إثبات أنك مسجل في جامعه بريطانيه.

Figure B.1: Task cards used in the lab controlled study

## B.4 Stakeholder Interview (Pre-Deployment): Questions and Comfort Scale

1. How do you feel about the idea of incorporating a robot into your daily workflow?
2. What thoughts, if any, do you have about working alongside a robot?
3. Can you envision any specific tasks or processes where a robot would be particularly helpful or beneficial?
4. How do you think your role or responsibilities might change or evolve with the introduction of a robot?
5. How comfortable are you with the idea of collaborating with a robot, and what factors influence your comfort level?

How comfortable are you with the idea of collaborating with a robot?						
Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree

Figure B.2: Stakeholder interview (pre-deployment): questions and comfort scale

## B.5 Stakeholder Interview (Post-Deployment): Repeated Questions and Additional Item

In addition to the questions listed in Fig. B.2, the following was asked during post-deployment interviews:

6. The robot has been in place for 2 weeks. Have your feelings about how a robot might fit within the workplace changed?

Figure B.3: Stakeholder interview (post-deployment): repeated questions and additional item

# Appendix C

## Supplementary material for Chapter 5

### C.1 NARS Questionnaire in Arabic

أوافق بشدة Strongly Agree	أوافق Agree	أوافق إلى حد ما Somewhat Agree	لا أوافق ولا أعارض Neutral	أعارض إلى حد ما Somewhat Disagree	أعارض Disagree	أعارض بشدة Strongly Disagree	
							1. سأشعر بعدم الارتياح إذا امتلكت الروبوتات مشاعر بالفعل. (I would feel uneasy if robots really had emotions.)
							2. قد يحدث شيء سيء إذا تطورت الروبوتات إلى كائنات حية. (Something bad might happen if robots developed into living beings.)
							3. سأشعر بالراحة عند التحدث مع الروبوتات. (I would feel relaxed talking with robots.)
							4. سأشعر بعدم الارتياح إذا أعطيت وظيفة تتطلب مني استخدام الروبوتات. (I would feel uneasy if I was given a job where I had to use robots.)
							5. إذا امتلكت الروبوتات مشاعر، سأتمكن من تكوين صداقات معها. (If robots had emotions, I would be able to make friends with them.)
							6. أشعر بالراحة عندما أكون مع روبوتات لديها مشاعر. (I feel comforted being with robots that have emotions.)
							7. كلمة "روبوت" لا تعني لي شيئاً. (The word "robot" means nothing to me.)
							8. سأشعر بالتوتر أثناء تشغيل روبوت أمام أشخاص آخرين. (I would feel nervous operating a robot in front of other people.)
							9. سأكره فكرة أن الروبوتات أو الذكاء الاصطناعي يقومون بإصدار أحكام حول الأشياء. (I would hate the idea that robots or artificial intelligences were making judgments about things.)
							10. سأشعر بالتوتر الشديد بمجرد الوقوف أمام روبوت. (I would feel very nervous just standing in front of a robot.)
							11. أشعر أنه إذا اعتمدت كثيراً على الروبوتات، قد يحدث شيء سيء. (I feel that if I depend on robots too much, something bad might happen.)
							12. سأشعر بالارتياح (الخوف الشديد) عند التحدث مع روبوت. (I would feel paranoid talking with a robot.)
							13. أشعر بالقلق من أن تكون الروبوتات تأثيراً سيئاً على الأطفال. (I am concerned that robots would be a bad influence on children.)
							14. أشعر أن المجتمع في المستقبل سيكون تحت سيطرة الروبوتات. (I feel that in the future society will be dominated by robots.)

Figure C.1: NARS Questionnaire in Arabic

# **Appendix D**

## **Supplementary material for Chapter 6**

## D.1 Student Support Center: Brief

**Interaction - Start**

1 How can I help you today?

2

**Interaction - End**

1 I would appreciate it if you'd rate our conversation by clicking on the tablet. Thank you and have a lovely day!

2

**Topics**

1 **Campus Navigation**  
Campus map or Google Map Links to: JMS, ARC, SRC, Admissions

2 **Official Documents**  
Instructions on how to print a bank or a certify letter

3 **Council Tax Exemption**  
Instructions for Glasgow City and other council residents

4 **Financial Aid**  
Help concerning:  
1. Student Loans  
2. Laptop Loans  
3. Hardship Fund

**Council Tax Exemption**

Do you live in Glasgow City Council or in another local authority?

**GLASGOW CITY**  
For further instructions, please scan the QR code below

**NON-GLASGOW CITY**  
For further instructions, please scan the QR code below


What's a Council Tax?  
Council tax is set by local authorities to provide services such as schools, rubbish collection, roads and street lighting. In Glasgow City Council, council tax is based on your property's value and size. You may be eligible for an exemption (such as a student) or a discount (such as a single person's discount).

Figure D.1: From an online presentation for the managers of the student support center

## D.2 RAS Drop-In Service: Brief

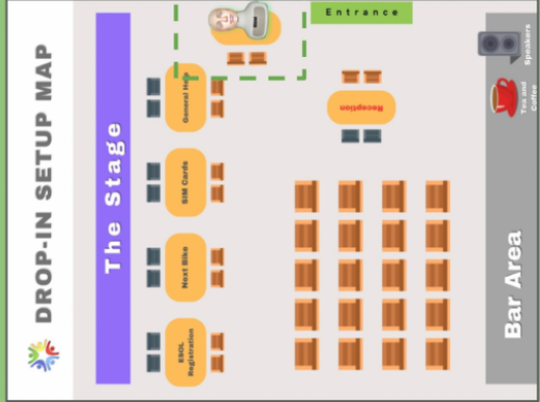
### Drop-In Support Robot

At the university of Glasgow, we are developing a social robot to work alongside human support workers who help new arrivals in a country to navigate the necessary bureaucratic processes in that country.



CWIN relies on the availability of volunteers in the drop-in service, and we suggest to add a robot that is always available.

This humanoid robot will be programmed to give information in Arabic to refugees and asylum seekers.



### Step-By-Step Process

The user chooses between Standard Arabic (official), Syrian Arabic (non-official) and English

1. User selects language on tablet.
2. Robot asks: "How can I help you today?"
3. Potential Topics: ESOL Registration, Bus Passes, Next Bike.
4. Scan for information (QR code).

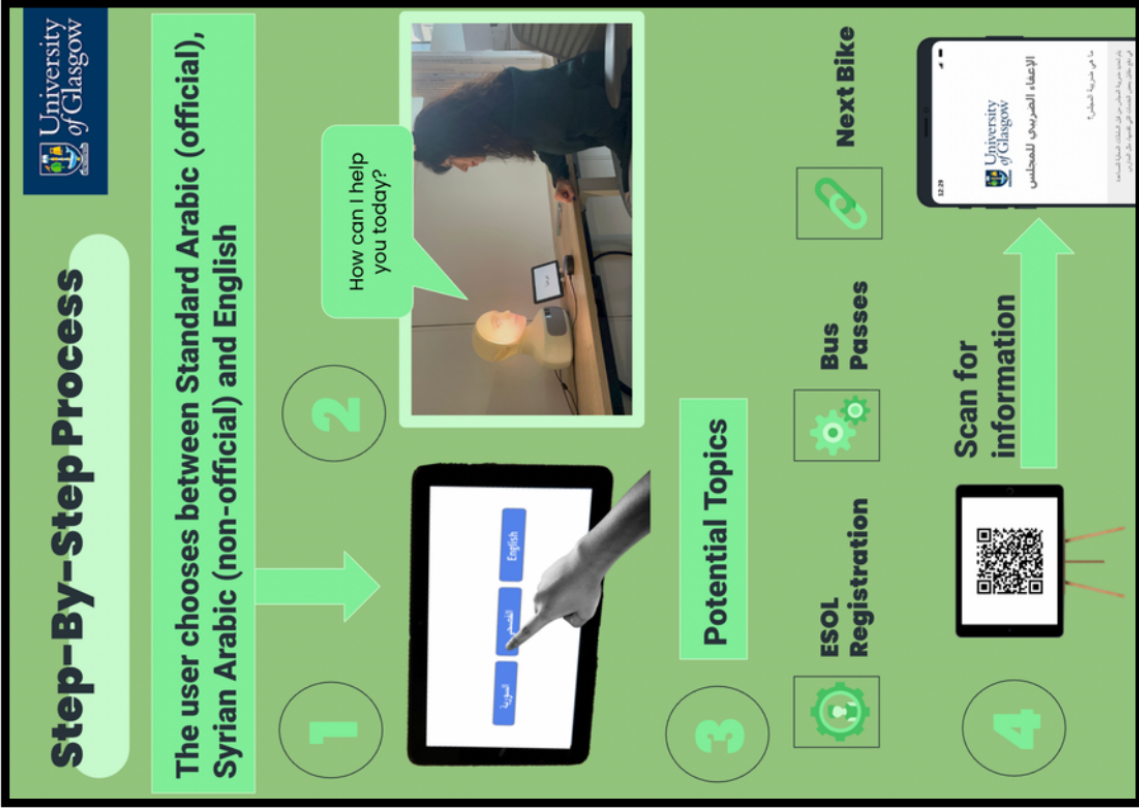


Figure D.2: A brief presenting the support robot for a meeting with the CWIN staff

### D.3 Online Resources for CWIN



# Food Hubs and Libraries Near Your Neighbourhood



Postcode: G1



Postcode: G1

Postcode: G2



Postcode: G2

Postcode: G3



Postcode: G3

Postcode: G4



Postcode: G4

Postcode: G5



Postcode: G5

Postcode: G9



Postcode: G9

Postcode: G11



Postcode: G11

Postcode: G12



Postcode: G12

Postcode: G13



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Postcode: G48

Postcode: G51



Postcode: G51

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Postcode: G53

Postcode: G58



Postcode: G58

Postcode: G62



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Postcode: G75

Postcode: G76



Postcode: G76

Postcode: G77



Postcode: G77

Postcode: G79



Postcode: G79

Postcode: G90



Postcode: G90



Social AI  
social-ctd.org

Figure D.3: Online Resources for CWIN: each QR code leads to a page detailing the three nearest food hubs and three nearest libraries to a specific neighborhood in Glasgow, Scotland