An investigation of humanoid robots and their implications for Australian public libraries

- Research Report -

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What is the impact of humanoid robots on Australian public libraries? This report presents the key findings of a project that responds to the question. Titled "An investigation of humanoid robots and their implications for Australian libraries", the purpose of the project was to provide a holistic picture of the role that humanoid robots play in Australian public libraries.

Method

The project adopted a qualitative research approach. To capture authentic insights, the researcher sought the views of 10 librarians in public libraries in Queensland, South Australia and Victoria. The librarians had experience as they were directly involved in humanoid robots in their libraries. Data collection involved individual in-depth interviews with all 10 librarians. Interviews were audio recorded and transcribed. The researcher also directly observed five events in five public libraries, in which the audience interacted with humanoid robots. Field notes were taken and used as a supplemental source of data for the research. A thematic analysis approach was used to analyse both sources of data.

Key findings

Data analysis revealed four themes that described the way humanoid robots impacts Australian public libraries. Humanoid robots are considered as:

A community builder

This role was represented via:
- Appealing to people
- Entertaining people
- Connecting and empowering people

A teacher

This role was represented via:
- Educating people
- Stimulating desire to learn
- Motivating people
- Awaking potential

An assistant

This role was represented via:
- Performing basic tasks
- Lacking flexibility in behaviours
- Playing supportive roles

A challenger

This role was represented via:
- Creating new challenges
- Requiring more expertise
- Requiring resilience

It is recommended that

- Public libraries (in collaboration with their parent organisations, i.e. city councils), devise a strategic plan for new and emerging technologies such as humanoid robots.
- Public libraries seek to expand their collaboration with other stakeholders such as universities and robotics centres where there are roboticists.
- Public libraries and city councils strengthen their relationships with robot vendors in order to take advantage of direct support.
- Library management boards and their librarians keep a good line of communication, especially issues related to humanoid robots.
- The community and other stakeholders consider humanoid robots in libraries as a work-in-progress.

Conclusion

This research has presented fresh insights about the impact of humanoid robots on Australian public libraries. The research findings were drawn from the lived experiences of librarians who directly plan and deploy humanoid robot programs and from direct observations of interactions between the robots and their audience. The findings could inform the development of such robotic programs in libraries to enhance the experience of library user communities.

Acknowledgement

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INTRODUCTION

BACKGROUND

Robots were initially utilised in industrial and factory environments in the early 1960's to carry out demanding and dangerous tasks. The development of robotics, coupled with artificial intelligence have made robots smarter, more human-like, more flexible and friendlier to humans. These robots are known as 'humanoid robots' or 'social robot' as they have the ability to work in social environments. Their topology, structure, and physical properties resemble the human body (Yamane & Murai, 2019). Pepper and NAO, for instance, are two examples of humanoid robots. According to their producer, "NAO is a bipedal robot with pleasantly rounded features" and Pepper is "able to recognise faces and basic human emotions. Pepper has no trouble in perceiving his environment and entering into a conversation when he sees a person" (SoftBank Robotics, 2019, para. 1).

Humanoid robots have been found in library and information settings (American Library Association, 2015), as Australian libraries have adopted such disruptive technologies in the last few years. The State Library of Queensland introduced the "State Library's Technology Trendsetters" program in 2015 enabling council libraries to "develop the digital literacy skills of library staff and the community" (State Library of Queensland, 2015, para. 3). This innovative program has put emerging technologies into practice. Noosa Library, "the first Australian Public Library Service to deliver a program using state-of-the-art robotics technology" (Noosa Library Service, 2016, para. 6), purchased a NAO robot to facilitate its STEM (Science, Technology, Engineering and Mathematics) program. Libraries in Victoria, New South Wales, and the Northern Territory have also started to embrace this emerging trend (Alice Springs Town Council, 2017; Geelong Regional Libraries, 2016; Regional Council Tamworth, 2016).

RESEARCH ISSUE BEING ADDRESSED

Although humanoid robots have only been around in Australian libraries for the past few years, they are playing an increasingly significant role in libraries and information practice (Tatham, 2016). They have carried out the task of librarians and supported them to deliver a range of programs and services. While the phenomenon is prevailing in the profession (Graham, 2016), discussion often occurs only on social media, and the impact of robots on libraries, librarians and patrons has not been empirically researched. The implications for current and future information practice have remained largely unknown. This research therefore aims to answer these questions by exploring the views of librarians who are directly involved in designing and running library programs and services using humanoid robots. It investigates the role robots play in the daily activities of librarians and library clients. In short, this research aims to respond to the following question: *What is the impact of humanoid robots on Australian libraries?*

SIGNIFICANCE OF THE RESEARCH

The research project has several benefits. From a personal perspective, it advances the knowledge and skills of the researcher in the area and informs his teaching practice. In particular, it develops the researcher's expertise in teaching emerging technologies for information practice, which provides students and practitioners with opportunities to engage and experience the latest technologies, such as mobile technologies, robotics and artificial intelligence, augmented reality, virtual reality, and their

implications in library and information settings. The research provides insights into his teaching, and in turn, will have a positive impact on Library and Information Science student learning. The project will also add to and expand the researcher's research agenda, which has a focus on technologies, people, and information.

At the institutional level, the research provides the researcher's university, i.e., Queensland University of Technology (QUT) with a better understanding of the impact of humanoid robots in a community setting. Particularly, it contributes to the QUT robotics centre's research strategy and direction that focus on the sustainable wellbeing of people and the environments they live in. The project also informs the research agenda of the QUT's Information Studies Group. As group members have an interest in teaching and researching areas such as robots, artificial intelligence, ethics, and information literacy, this research enables them to further enhance their teaching practice and inform new projects in these areas.

The research also contributes to not only the general knowledge of the library and information sector, and its outcomes are beneficial to a wide range of stakeholders. It provides librarians across Australia a deeper understanding of the way in which humanoid robots affect their duties and operations so that librarians can tailor programs and services to improve customers' experiences in public libraries. In turn, library clients and the wider community will benefit from the innovation and enhancement of library services.

REVIEW OF THE LITERATURE

Robots were predicted to "have the single greatest impact on an organisation's strategic planning" (Gartner, 2016, para. 4). Such a prediction is based on the fact that social robots can undertake social human-robot interactions (Yan, Ang, & Poo, 2014; Young et al., 2011). According to Bartneck and Forlizzi (2004), to socialise and have influence, social robots need attributes such as form (the appearance or friendliness of the robot), modality (the ability to communicate in different channels e.g. the visual, auditory, haptic, olfactory and even gustatory channels), social norms (the exhibition of reciprocal social norms), autonomy (the technological capabilities to act on behalf of humans without direct input from humans), and interactivity (the potential to exhibit causal behaviour or to respond in reaction to interaction with a human). These properties inform not only the design but also the implementation, use, and evaluation of social robots in community settings.

In practice, robots have been present in a range of professions. In health care, for example, social robots are used as a personal assistant and carer of the elderly because they are able to converse and interact with humans and can contribute to "the health and psycho-logical well-being of the elderly" (Broekens, Heerink, & Rosendal, 2009, p. 1). In education, humanoid robots support learners in various learning activities (Belpaeme, Kennedy, Ramachandran, Scassellati, & Tanaka, 2018). They can motivate and support primary school children in reading (RoboticLab, 2019), developing their language and communication skills and improving their social-emotional learning experiences (Chang, Lee, Chao, Wang, & Chen, 2010; Crompton, Gregory, & Burke, 2018). Humanoid robots are also used as research tools in areas such as biomechanics (Li & Wu, 2013; Perico et al., 2018) and neuroscience (Kinouchi & Mackin, 2018).

In the library and information practice, humanoid robots take on different tasks. They are used in libraries to help with shelving and maintaining collections (Blakemore, 2016), conducting library tours (Gartner, 2016), and circulation (Lin, Yueh, Wu, & Fu, 2014). They can help young patrons in school libraries in developing their communication, learning, and problem-solving skills and creativity (I Love Libraries, 2016). They also teach public library users basic computer programming and robotics skills (Farrukh, 2014; Pena, 2018; Schaffhauser, 2019). Such social robots can also support in providing storytelling sessions thanks to their friendly appearance and ability to converse with clients (Mackay Regional Council, 2017). Due to having features such as arms, hands, and eyes, they can use body language, dance, play games, and share historical stories with library-goers. For these reasons, humanoid robots are even referred to as "a new library staff member" (Tatham, 2016, para. 2).

With regard to the future of humanoid robots in libraries, researchers and practitioners are concerned about whether these type of robots will have a negative impact on libraries and whether they will shape libraries and replace human librarians (Tay, 2019). There is a fear that the robots will eliminate the relationship between people and information, librarians and the public community (Bourg, 2017; Cockshott & Renaud, 2016) and dominate our daily lives because of their ability to outperform humans in different areas (Kim, 2015). On the contrary, robots are believed to be promising to library services (Yao, Zhang, & Chen, 2015). Though predicting the future of humanoid robots in libraries is not an easy job, Calvert (2017) asserts that "if computers, robots, whatever we call them, become more efficient, more effective, and (tellingly) cheaper, than humans, it is inevitable that they will begin to do some library work instead of us" (p. 171). Importantly, the librarian must be a leader in order to shape this change in a positive way because "an important part of leadership is not just responding to changes, but actually getting in front of those changes when we can" (Bourg, 2017, para. 14).

RESEARCH APPROACH

This study adopted a qualitative research approach. Qualitative research attempts to understand and make sense of phenomena from the participant's perspective. The researcher can approach the phenomenon from an interpretive and critical stance (Merriam, 1998). The qualitative approach is an enquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in a natural setting (Creswell, 2003). It focuses on a participant's knowledge, emotions, and feelings, and therefore, is suitable to discover the meaning or the nature of their "lived experiences" (Strauss & Corbin, 1998, p. 11).

The use of qualitative research approach in this study enabled the researcher to explore the influence of humanoid robots on Australian public libraries from the stakeholders' perspective, i.e. librarians and library customers. Thus, it allows the researcher to "enter into the world of participants, to see the world from their perspective and in doing so, make discoveries that will contribute to the development of empirical knowledge" (Corbin & Strauss, 2008, p. 16). It enables the researcher to deeply interact with and participate in data collection to exploit the intangible knowledge and lived experience that is not always documented and available in physical formats (Strauss & Corbin, 1998).

DATA COLLECTION

To gain multiple perspectives, data collection for this research included individual interviews with librarians and observations of humanoid robot events in libraries. Ethical clearance was gained from Queensland University of Technology for data collection activities (See details in Appendix 1).

INTERVIEWS

Research participants were librarians in public libraries across Australia. The researcher did an initial review of literature and an environmental scan to identify public libraries in Australia that had already deployed humanoid robot programs and services. A convenient sampling approach was used. An individual invitation email was sent to each library manager, digital learning coordinator and/or people who were responsible for the developing and running such a humanoid robot program to invite them to participate in the research (see details in Appendix 2). Gender balance or representativeness of the research population is not the concern of a qualitative study provided that participants are information-rich informants (Strauss & Corbin, 1998). Ten librarians in public libraries in Queensland, South Australia and Victoria, including one male and nine females were recruited. Their experience with the humanoid robots ranged from several months to three years.

Ten in-depth individual interviews were conducted with the accepted librarians, taking place either face-to-face, online, or via telephone. The length of each interview was between 35 and 50 minutes. All interviews were audio recorded and transcribed. The interviews were conducted in a conversational manner using a semi-structured set of questions. The following questions are indicative of the ones asked during the interview rather than an exhaustive list of interview questions (See details in Appendix 3):

- Can you tell me about the way your library uses humanoid robots in designing and delivering library programs and services?
- What have been the key achievements in using the humanoid robots for your library?

The main purpose of these open-ended questions is to learn about the experience of librarians. The questions encourage them to share their opinions about the humanoid robot-based programs and services and stimulate them to talk about their perception and expectation of the robots in the current and future library. Apart from the main questions, probing questions such as, "Can you tell me more about it?" or "Can you give me an example?" were also used to seek further explanation or to add details to an issue of interest.

OBSERVATION

A non-participant observation approach was used to understand librarians and library users experience of humanoid robots in libraries. This additional data collection method can offer a more nuanced and dynamic appreciation of situations that cannot be easily captured through other methods (Liu & Maitlis, 2010). The selection of library sites and events for observation was dependent on the availability of the humanoid robot programs that libraries offered during the data collection period between August and December 2018.

Five events at five libraries were selected for observation. They included informal sessions (i.e. drop-in and interact with humanoid robots), which were open to the general public, and training classes (i.e., coding with NAO) which are open to teenagers and requires attendees to enroll in advance. The open event attendants reflected a diverse population, including children and their families, adults, and the elderly. The training events included teenagers aged between 10 and 14, who were either native or English as a Second Language speakers. The researcher was part of the crowd in each event and in the role of a general public member or a parent/care-giver accompanying a teen. He observed the events from a sufficient distance by watching participants interacting with the robots and the accompanying librarians. A notebook and pen were used to record detailed notes of relevant activities within the events. Observations were generally guided by the following (Silverman, 2006)'s questions:

- What are people doing? What are they trying to accomplish?

- How exactly do they do this?

- How do people characterise and understand what is going on?

- What assumptions do they make?

- Analytic questions: What do I see going on here? What did I learn from these notes? Why did I include them?

These questions enabled the researcher to direct the focus on people who watched and interacted with the robots. They helped capture the reactions, emotions and feelings of the participants and therefore provide insights into the role and impact of humanoid robots in libraries.

DATA ANALYSIS

Interview transcripts and field notes were thematically analysed. This analysis process was mainly guided by Braun and Clarke (2006) in combination with the use of a constant comparison technique, a data analysis technique commonly used in grounded theory (Strauss & Corbin, 1998). Three main types of comparisons were made, including one piece of data to another (or incident to incident), concept to incident, and concept to concept. Such comparisons generated a list of concepts (codes), which were repeatedly validated against the data and other concepts. Rather than developing a theory, the use of this comparison technique in this research aims to "stimulate thought that leads to both descriptive and explanatory" themes (Lincoln & Guba, 1985, p. 334). Specifically, the following main steps were carried out:

(1) Preparation: Reading transcripts/field notes and noting down initial main ideas.

(2) Coding: breaking down and examining transcripts/field notes; generating codes (concepts) and collating excerpts relevant to each code.

(3) Themes identification: collating and sorting codes (similar codes were grouped to establish potential themes; gathering all excerpts relevant to each potential theme.

(4) Reviewing and defining themes: checking if each theme represents ideas in the relevant coded excerpts; refining and naming themes.

(5) Interpreting and reporting: interpreting themes, giving examples, and writing the report.

Steps (1) and (2) were first done on paper and then transferred to a computer using a software program named MAXQDA version 10. The software helped organise, manage, extract, and present data, which were the focus of steps (3), (4), and (5).

RESULTS

This section describes four themes that were revealed during the data analysis process. These themes appeared frequently in the data, meaning that in most, if not all cases, there were indicators pointing to the themes. They reflect the experiences and general observations of participants. Accordingly, humanoid robots in Australian public libraries were viewed as (1) a community builder, (2) a teacher, (3) an assistant, and (4) a challenger. These four themes are delineated below. Selected excerpts from interviews (abbreviated as 'int.') and observation notes (abbreviated as 'obs.') supporting each theme are also included to illustrate the point being made.

THEME 1: HUMANOID ROBOTS AS A COMMUNITY BUILDER

This theme describes the way in which humanoid robots in Australian public libraries helped develop the library community. Humanoid robots are used to make libraries more appealing to the general public. A range of activities were designed using said robots to attract people, entertain them and encourage them to join the library community.

Appealing to people
Drawing people to libraries was the main purpose of humanoid robots. *"We do try to do drop-in sessions at a time when we expect to bring people to the library so that we maximise people potential expose to that program" (int.1). "Our sessions, especially drop-in sessions are open to the whole community" (int. 2).*

The humanoid robot programs were intended to reach the widest audience possible. Libraries scheduled and advertised the sessions in advance, so people could be notified beforehand in order to come along to one of the sessions and engage with the robots. *"Drop-in sessions were often placed next to the entry or in the main part of the library rather than in a meeting room, so people can easily hear the robot and see something going on and they come closer and engage" (obs. 1).*

Libraries also actively encouraged people to engage with libraries through outreach programs. One librarian stated, *"we aim at every age group from the outreach mobile libraries and take it [the robot] out to remote communities" (int. 5).* Another librarian talked about an activity that they did as part of their outreach program, *"we took a NAO to a primary school last year and spoke with the children in the assembly where NAO did Gangnam style and all children in the hall danced, which was really good" (int. 7).*

Robots like this made sessions appealing to all ages and is the reason why people want to engage with it. The researcher observed that *"there are a lot of children in the library, and their parents may think that the robot sessions are only aimed towards kids. However, they are directed at not only children with their families, but also adults and the elderly. People are interested far more than just what is demonstrated engage with the robot. They asked questions on how the robot functions, and what programming language was used to program it, and whether the robot is equipped with artificial*

intelligence" (obs. 1). A librarian asserted, *"we don't exclude any demographics. We don't think it is for only children. It is really technology for everyone and we really want to reach everyone (int. 1).*

Entertaining people

Libraries created entertaining sessions for the community thanks to special features of humanoid robots. They can carry out a range of physical movements, sense the environment and respond to it. A librarian revealed the abilities of NAO (a specific humanoid robot) and how her library used it: *"He can walk forward and backward, can introduce himself, do some animated safe movements. He plays guitar, do some Taichi moves. We would demonstrate speech recognition, so we would ask NAO some questions and get some responses. We also do some dances" (int. 7).*

People appreciated the robots' friendly appearance, its mobility and its interactive abilities. The use of humanoid robots is also entertaining. This is a note taken during a Pepper robot session in a school holiday, which says: *"Children and their parents were standing in front of the Pepper robot seeing the performance. The robot played the sounds of animals and asked the audience to guess and say the name of animals" (obs. 4).* The robot was also able to introduce authors, tell stories and play simple games with the audience. *"We have NAO programmed to tell stories. We have points in the stories where we have NAO responded. For example, NAO is telling stories such as Three Little Pigs and he will face and ask what is the next. What will the next Pig build, a house shadow? Some audience come forward to respond. It doesn't have too much knowledge, but they can trace recognition and ask someone to point the correct answer. We pre-programmed NAO to respond to even incorrect answers (int. 1).*

People also find it amusing to exercise with the robots. "*People enjoyed seeing the robot physical. They can sit down and stand up and lay down and can do Taichi. That kind of movement is really powerful for people to see because they know how their own bodies move and see the robot doing the same thing. It is very exciting (int. 2).* A librarian concluded that *"the best thing about having NAO is the crowd pleasure. It is a lot of fun" (int. 6).*

Connecting and empowering people

Humanoid robots helped change people's opinion on libraries. *"You probably hear that the public library is quiet, and if you don't read there is no reason for coming to the library. Probably Pepper is attracting the dynamic. People tend to be motivated in attending it because the robot is there. It is shaping the idea of what the public library is" (int. 3).* Another librarian added that *"they [humanoid robots] present movements, they present community hub, technologies – such a beautiful representation of moving forward or not staying stagnant" (int. 10).*

As people see the dynamic of public libraries, they come and participate in common activities such as programming with robots and meeting/interacting with them. A librarian discussed a strategy to bring technologies to life: "*We already had a range of programming and coding robotics including robots and the Dash and Dot robot. But we wanted to get a NAO robot specifically because it is a humanoid robot and we wanted to start normalising humanoid robots in the community" (int. 8).*

The more people are aware of emerging technologies and their role in their daily lives, the more accepting and knowledgeable they are of them. In a plenary session with humanoid robots, it was observed that *"not only children enjoyed the robot, but their parents and the elderly also had a lot of*

questions about the mechanics of the robot, the language used to program the robot, and the robot's intelligence. People appeared to be confident and eager to know more. The librarian quickly showed them the code that was produced for the session and explained it to them. People were also introduced to a range of programs related to humanoid robots and new technologies that may be of interest to them and their family members" (obs. 5). Activities like this helped increase the level of understanding among the community so that they can be more independent in dealing with new technologies and take advantage of it for their daily activities.

THEME 2: HUMANOID ROBOTS AS A TEACHER

This theme portrays the educational impact of humanoid robots in Australian public libraries. Participants reported that their libraries used humanoid robots to develop people's understanding of new and emerging technologies. They stimulated people's thinking about technology and its potential in the future. They also enabled people with special needs to learn more effectively.

Educating people
Libraries wanted to give its visitors opportunities to be exposed to technologies as much as possible through the use of humanoid robots. A participant explained: *"We wanted to normalise the use of the robot in libraries for the whole community" (int. 8).* Another participant detailed: *"We know that children and young adults will soon have robotics as part of their working lives, so it is a responsibility to make sure that all children have opportunities to interact with robots in a number of programs, using different types of robots to keep up with a range of skills, and a range of coding opportunities that we offer. That is really about giving people opportunity to see what its potential is and see what it is" (int. 7).*

People can take part in such an education program in a formal or informal way. They can either enrol in a coding class with robots and learn with other people, or drop into an informal session and interact with the robot instead. Acting as a facilitator in a coding-with-humanoid robot session, a librarian stated that *"it is not just about a formal learning process. We deliver classes in our program using a Python based Choregraphe software for small groups of kids. But more than, that we want to see the robot in action in the library, being able to interact with and really, I suppose to get that idea where technology may head in the future" (int. 2).*

Informal sessions were often scheduled and advertised to the public in advance. It was noted in an observation of one of these events in a public library that *"the session took place in a large area leading from the library's main entrance. There were about 30 attendees, including families with kids, young adults, adults and elders. The robot performed a variety of tasks such as moving left, right, forward and backward, playing guitar, doing Taichi and lying down and sleeping. After a while, the librarian explained the robot's body parts, which lead to a discussion" (obs. 3).*

Stimulating desire to learn
Humanoid robots stimulate a desire to learn. Learning to code, for example, is often viewed as a challenge. However, the creative use of robots can make the process easier. A librarian explained the strategy of doing this like so: *"we run a small group workshop for programming the robot and they are for kids 9-12. We have 10 kids and we have both robots at the session, and the kids work on laptops to*

code their scripts and then upload them to the robot to see it in action. So, the benefit of that has been, I guess, the ability for kids to learn good coding skills, from doing it from scratch to actually seeing the program in action. You know, the physical humanoid robot has been a very effective way to stimulate their learning desire" (int. 8).

The robots also stimulated people's curiosity. It was observed in a session that *"library customers did not seem to be interested in the robot sessions, as few people attended them at the beginning. However, after the robot's demonstrations, people started to come and join the sessions" (obs. 2).* A librarian facilitating one of these sessions revealed that *"there are people who are really impressed and have a next level of interest and we might have a quick look at the software and show them what Choreograph [the programming language used to control the NAO robot] looks like so they have a simple overview. They really have a next level of interest" (int. 1).*

Noticeably, people considered learning with robots as a lot of fun. They learned by playing with something new. When talking about this method of teaching and learning, participants regularly used words such as *"interactive learning" (int. 2), "deep learning experience" (int. 6),* and *"learn and have fun" (int. 10).* When comparing features and functions of the humanoid robots and Siri (a virtual assistant integrated into iOS devices which uses voice recognition and natural-language abilities to communicate with humans), a librarian affirmed *"when we first got the NAO robot people won't be using Siri" (int. 7)* because NAO is more visual, interactive and friendly.

Motivating people
Humanoid robots inspire people to learn. A librarian enthusiastically stated that *"the robot made kids more confident, so they love it and want to interact with it" (int. 5).* This leads to a new learning experience because *"many participants speak a second language and they have great fun practising English with Pepper. But the thing is, Pepper doesn't understand their accent, so they must adjust their voice to be understood. That is probably an interesting thing about using the robot" (int. 9).*

The robots can encourage English as a Second Language students to practice their English. A librarian explained that *"because they really want to interact with the robot, but I explain that if you say 'sitz down' the robot is not going to sit down. You have to speak very clearly…So most of them become more likely to say 'sit-down'. It [the robot] actually required them to speak very clearly and they improve their English" (int. 3).*

Awaking potential
A librarian explained why her library purchased a humanoid robot, saying: *"We want to have a humanoid robot because we saw a very creative way of helping kids to learn because some of them don't respond well to the traditional methods of learning" (int. 9).* The robots are also believed to have a positive influence on autistic children. Another librarian told a story about how the robot awakened a child's learning desire:

"There was an indigenous student in the school where my friend has been the teacher of 22 years. She takes all the kids with learning difficulties; and there is one little boy who would not interact with her. He would not stay with the timetable. He would not do anything. So, she came down to the library one afternoon and we did a personalised greeting [programmed the robot to greet him] for the little boy. You know, 'Hi Alex! how are you?' It was a lovely day. You know, 'I like to do my timetable with you',

would you do this with me?' And he had no problem with interacting and doing the timetable with the robot while wouldn't do it with the teacher! You know, he didn't have that sort of confidence. He seemed to lack the confidence with the teacher, but with the robot, I don't know, he would do whatever the robot was asking him to!" (int. 3).

In another instance, humanoid robots were also believed to have changed people's behaviours. A librarian reported an instance where she used a humanoid robot to help with a child's confidence, saying: *"There was a little autistic boy and his mum asked me to do an hour with him every Wednesday because there was a program on the robot that catered to his needs, so she brings him to the library. You know, he wouldn't talk much or interact prior, but she said that as soon as he leaves the library he is talking all the time 'why bot, why bot, why bot this, why bot that', so she was really happy with that because it made him interact more. He interacted more with the robot than he would with his parents"* (int. 9).

This theme denotes the supportive role of humanoid robots in Australian public libraries. A collective view among participants was that while humanoid robots carried out various library activities, they were only assisting librarians rather doing the tasks on their own. However, it was also acknowledged that such robots will have a promising future in public libraries.

Performing basic tasks

Humanoid robots were able to implement simple tasks in libraries. They helped build communities through assisting staff in teaching coding classes, telling stories to library visitors, and helping out with 'show and tell' sessions. It's worth noting that the robot could only perform well under the supervision and care of a human librarian, who has been quoted saying that "*it is just a basic machine" (int. 6).* Another librarian explained the importance of human involvement, saying: *"when you look at the humanoid robot you don't necessarily take into account the human working with it. Because the best-case scenario is that the robot is coded, put out there and it works, and it doesn't need much mentoring. But you are the centre dealing with the people. It couldn't move too fast, it couldn't do certain angle. You have to position it, so you have to make sure that people are not coming up and put their fingers in the elbow because it can react wildly"* (int. 10).

A librarian who was responsible for the operation of the robot talked about the type of tasks the robot in her library could do: *"The only thing that we use Pepper for is a little bit of entertainment. We have programmed him [the robot] with a series of activities such as reading about 3 or 4 books that we have downloaded. Picture books that we go through on his tablet and go through in sequence with him to read the book. A couple of songs and a couple of things such as animals talking about themselves" (int. 4).* It was further explained that *"it can only make decisions as to the logic that is programmed. Pepper can understand my accent, and different words or different genders would be misunderstood. I mean it makes the best guess to what you have said. It's only as good as your programming skills because it can only act how it has been instructed" (int.6).* This means that the robot could only perform supporting roles rather than control things on its own. There had to be support from a human librarian along with appropriate instructions and care whenever it was in operation.

Lacking flexibility in behaviours

Participants shared that while humanoid robots are good as assistants, they cannot replace and outperform human librarians, the reasoning being that robots don't possess any emotions. A librarian further explained it like so: *"I see someone walking into the library, I can sort of tell if he is in a hurry, or what book he likes or something, but he [the robot] can't do things on a personal level like that. He can do what I am asking him to do, what I program him to do, but he can't see people's emotions and needs in that way" (int. 9).* Another librarian elaborated on this point: *"Because the role we provide requires so much intelligence and thoughts. Just like it can't replace the researcher because there is critical analysis" (int. 8).*

Besides the robots' lack of emotional and intellectual ability, there were also nuanced aspects that only exists in humans. A librarian clarified this as: *"it is really about human body language and signals which are so sophisticated. People [library customers] might ask something else, or they want to be supported in another way. You know, there is a lot of nuances in what we are doing in the public library" (int.1).*

Another aspect is that since public libraries also serve as a community hub, people come to libraries for not only information, but also for social interaction. *"Older adults in the community really like the personal touch in the library" (int. 3). "Having a humanoid robot in the library can help with something, but it would be better to have a human presence in the library" (int. 5). "The robot needs to be accompanied by staff members. There are many things that can go wrong. It can't understand human issues. It is really important to have a staff member to facilitate questions. The robot can assist but is not able to lead" (int. 1).*

Playing supportive roles

Participants supported the idea of humanoid robots in public libraries. However, it was believed that people were exaggerating what humanoid robots could do, *"it is a little bit fearmongering" (int. 2). "There is a distracting trend in libraries – it goes, wow, that [the humanoid robot] is new and shiny – worth viewing. And then they go 'can't you do that with it?' I think that it a pitfall of it" (int. 5).*

In an observation of a coding class using the NAO robot, it was seen that *"the librarian facilitated the class and the robot acted as an aide. Students produced code in Choregraphe to get the robot walking and talking. They then transfer the code to the robot to see it in action. The robot's actions then indicated if the code worked, but it could not teach students on behalf of the librarian, i.e. how to debug or rewrite the code" (obs. 3).*

In public libraries, *"humanoid robots have a big future. Because as I said, older people like personal human factors whereas young people and the younger generation like robotics" (int.3).* A librarian stated that the robot can do more complex tasks such as providing directional information: *"the robot can be designed and programmed for a specific purpose … we would have Pepper access Wikipedia, so any one could ask a random question and Pepper would give the answer" (int. 9). "At the moment, the humanoid robot can do things in a very structured way. Its potential could be realised, and it could do more than a supporting role, but it will take a long time to make it worth it in public library settings" (int. 10).*

This theme depicts difficulties that librarians experienced when humanoid robots were adopted in Australian public libraries. It also details complications that required the librarians to be resilient in order to remain in control of their everyday activities.

Creating new challenges

Librarians faced new challenges when humanoid robots were introduced in libraries. As an early adopter of the robots, they had to deal with a new or even a demo version of the robots, which were generally perceived as difficult to use. *"It [the humanoid robot] is a complex system. If you don't fully understand it then you shouldn't be adopting it" (int. 6). "The robot needs to be full of battery or connected to a power source. It needs to be connected to a Wifi network and to Choregraphe [which was believed to be a complicated software program]" (int. 4). "There are a lot of things about reliability because like any technology, troubleshooting, especially on the spot, for example Wifi drops out, we need to get it reconnected. We have 25 people standing there watching. You know, that kind of confident trouble shooting on the spot sometimes is challenging" (int. 2).*

Furthermore, a complaint was that the robot was easily affected by the surrounding environment. *"It got distracted by loud noises, shifting in light patterns and things like that" (int. 10). "Sometimes Pepper works fine. However, he is very sensitive to things like threat of light, very sensitive to noise. Someone in the library corner calls out and he suddenly switches off. He is very sensitive to our setting... Also, he is not very portable. We want to be able to utilise him in every location [every library branch], not just one, but it is not very convenient" (int. 4).* Another librarian added that "*we had one – literally one spot in the entire library Pepper would work effectively" (int. 9).*

The challenges not only came from the robot itself, but also from the management plan and support. Some libraries had a strategic plan in purchasing and utilising humanoid robots, but others were not in a position to control the process, and were given a humanoid robot without a clear plan. A librarian stated that "*they [the management] didn't deem it appropriate to purchase the much more user-friendly software and so and they weren't aware that it existed until recently - big cranky about that. They decided to buy a very expensive robot but not the support software to go with it" (int. 4).*

Requiring more expertise

The adoption of humanoid robots in libraries demanded new knowledge and skills in order to make full use of them and create meaningful programs, but there was a steep learning curve. *"It takes many hours to become comfortable using the robot. And it's designed for one to learn that it is not a transferable skill for us. It is unique for NAO. We don't use that software [Choregraphe] in any other context (int. 8).*

Learning to control a new piece of technology like a humanoid robot was demanding to librarians as the task is technical heavily. *"You need to learn not just one, but two different coding languages between Choregraphe and Python, which are both super difficult" (int. 5). "The level of coding knowledge required for both NAO and Pepper to get full functionality of it is above standard for a basic librarian role" (int. 6).* The learning required librarians to develop multiple skills and improve their knowledge, not only in librarianship but also in information technology and robotics. However, a

librarian reasoned: *"We aren't coding experts, we are not IT specialists. We are librarians, we are information experts. It means we have a strong commitment for life-long learning and our own professional development. But the NAO robot isn't a simple piece of technology like an iPad. So, the learning curve in terms of being able to feel confident using the robot to a point of being able to demonstrate it to other people in a knowledgeable way is probably more severe than any other technology that we use in the library"* (int. 2).

The humanoid robots required well trained professionals. Metropolitan libraries might have one or two technical-minded librarians who could learn to control the robot and then teach other colleagues in their libraries. However, smaller libraries were not as lucky, as they had a shortage of staff and often had only a couple of weeks to train, which mainly consisted of self-learning, before running the robot program for the public. They had no on-site support and limited access to technical support from external stakeholders. For this reason, it is not easy to have a well-trained staff member who can fully control the humanoid robot program. *"We don't have a large pool of staff who are trained about using the NAO robot. Most of our staff could teach someone about using an iPad, just a few staff could use the robot in the same way"* (int. 8). Importantly, as in other technological areas, librarians had to keep their training current. *"If someone did that training a year ago, and they haven't run a NAO event since then, then they need to be retrained because the program is complex"* (int. 7).

Requiring resilience
There was a shared opinion among participants that humanoid robots brought in a fresh perspective on libraries and changed their programs and services in a positive way. However, they had to cope with challenges that they had not experienced before, which required them to do everything possible to keep things under control.

Librarians in large libraries had to overcome themselves to regulate emerging technical issues associated with the robot. However, they were still luckier than their colleagues in regional and remote libraries, as they still had management support and strategic plans. Some librarians in remote areas were strapped for time and had almost no access to necessary resources, training in order to operate the robot effectively. *"The people who purchased him do not work in the library and don't have a clue but decided to purchase it. They thought it would be good. They though he [the robot] would do this or the other"* (int. 4). *"There is no consultation. They just bought it, handed it over and asked us to do everything with it"* (int. 10).

Other hurdles came from the attitude of the public towards the robot and what librarians were doing. *"You have to face reality. You have to face the fact that you wouldn't have training or that the public isn't nice. You've got kids running. You've got adults saying, 'take it up and take it out of the door'. So, you have to think about it in isolation"* (int. 3). Another participant librarian admitted, *"we couldn't work out enough different varieties to stay fresh. Because once the kids see and say, 'can it do this or do that?' We say we can't. Because it is high-end level of coding. We only do the basics"* (int. 6).

It was further explained that there was an unrealistic expectation towards humanoid robots. ***"They go with an idea, wow, we can have the robot to do really great greetings. The robot is an ambassador that is there consistently on the floor the whole time...But Pepper couldn't do this. We couldn't leave Pepper unattended. So basically, you are hiring a staff member and using the staff to stand beside the robot full-time and it is not a good return on investment in terms of staff time"* (int. 5).

The study provides a holistic picture of the way in which humanoid robots influence public libraries in Australia. It provides evidence-based understandings to support humanoid robot initiatives for enhancing library services. Key findings below are summarised and discussed.

Humanoid robots as a community builder

The findings that illustrate the role of humanoid robots in community development are as follows:

- Appealing to people
- Entertaining people
- Connecting and empowering people

The findings of this study show the advantage of using humanoid robots to build a community. These robots should not necessarily be considered a tool, and to a certain extent, they create a fresh view on libraries and make libraries more appealing to the community. It is noteworthy that the robots do not simply draw people's attention or market libraries. Patrons come to the library to be connected to others, i.e., joining robot sessions, discussing technology, and learning together in coding classes. Naturally, these activities help increase the level of confidence among the community, especially the younger generation and the elderly. Thus, the library helps develop a passion for technologies, prepares young people to live and work in the ever-changing world of technology, and aids older people in confidently living their lives associated with technology.

While Gartner (2016) predicts that smart robot will "have the single greatest impact on an organisation's strategic planning" (para. 4), the findings of this research suggest that humanoid robots, although not having the greatest impact, have played a significant role in library services. This role is fulfilled thanks to the good design of the robot in terms of form (the appearance or friendliness of the robot) and modality (the ability to communicate through different channels e.g., the visual, auditory, haptic, olfactory and even gustatory channels) (Bartneck & Forlizzi, 2004). A more tailored plan and a further improved version of humanoid robots in the future will likely help provide a better experience to customers in the future.

Humanoid robots as a teacher

The findings show that humanoid robots in libraries play an educational role in different ways:

- Educating people
- Stimulating desire to learn
- Motivating people
- Awaking potential

It is noteworthy that educating people is not the main function of public libraries. However, humanoid robots, along with librarians, both play a teaching role, which the community appreciates. The robots not only increase people's awareness of new and emerging technologies, but encourage them to learn in natural and enjoyable ways. In this respect, Australian public libraries have expanded their role, i.e., not only providing information and associated services, but also teaching people. They display a strong commitment to facilitating life-long learning in the community.

The research findings suggest that humanoid robots help Australian public libraries provide a higher level of education and training to people. They also take a bigger role in educating autistic children and enabling them to do what they could not before. While literature often reports that humanoid robots help school children in developing their communication, creative and problem-solving skills (I Love Libraries, 2016) or in teaching public library patrons coding skills (Farrukh, 2014; Pena, 2018; Schaffhauser, 2019), none of it states that public libraries teach these skills to children with learning difficulties. While Australian public libraries do not teach autistic children complex skills as mentioned above, the findings indicate that humanoid robots help public libraries implement something new and interesting, which is awaking and stimulating children's learning desire.

Humanoid robots as an assistant

The findings point out that humanoid robots have an assistive rather than a leadership position, which includes:

- Performing basic tasks
- Lacking flexibility in behaviours
- Playing supportive roles

While some are concerned about humanoid robots taking the place of humans (Cockshott & Renaud, 2016; Tay, 2019), current findings indicate that robots play a supporting but not leading role to librarians. They are often regarded collectively as an assistant or a helper who contributes to the delivering of library programs to patrons. A participant librarian stresses that *"it is a little bit fearmongering" (int. 2),* and this is "*a distracting trend of library" (int. 5).* We cannot deny that these robots provide great support to librarians in attracting people, delivering story-telling programs and/or teaching students. However, the nature of the tasks that robots do is quite simple. Furthermore, there is always at least one librarian accompanying the robot whenever it is in action in public. From this perspective, the level of autonomy - the technological capability to act on behalf of humans without direct input from humans (Bartneck & Forlizzi, 2004), is low.

There are possible reasons for the humanoid robots' lack of autonomy in Australian public libraries. The common reason given by participant librarians is that their robots are often the first or a demo version. Furthermore, there is a lack of on-site technical support, and librarians do not have sufficient access to necessary resources to learn and operate the robots. Robotics will move fast, and associated technologies such as artificial intelligence and machine learning will develop quickly too. So, it may not be an overstatement to say that humanoid robots will outperform human librarians in some areas such as searching, reading and analysing. But there should be jobs for librarians, especially in areas such as understanding the human aspects of library patrons, which requires nuances and human abilities. As indicated by IFLA, "a good librarian, through working with a user, can provide a much better tailored service, potentially using up time freed up by using AI [artificial intelligence]" (International Federation of Library Associations and Institutions, 2018, para. 8).

Humanoid robots as a challenger

The research findings suggest that humanoid robots introduce new difficulties to libraries and librarians by:

- Creating new challenges
- Requiring more expertise
- Requiring resilience

While existing discourses mainly focus on the benefits and potential of humanoid robots in libraries, they do not seem to acknowledge disadvantages that the robots bring in. It is evident in the findings that while humanoid robots contribute to the library to a certain extent, they also introduce new dilemmas. As early adopters of humanoid robots, librarians are challenged to a new piece of technology without sufficient support, which makes their learning curve sharper. With the exception some libraries and librarians who are lucky enough to be well-informed of the humanoid robots plan in libraries, other librarians were not in a position to master the adoption process. Noticeably, some librarians must deal with the new robots on top of their full-time job, meaning that an extra job responsibility is given, leading to frustration at times.

Whereas humanoid robots assist librarians in some tasks, they also require their human colleagues to play multiple roles. Apart from a librarian role, to a certain extent, they must also be a robotics expert, an information technology technician, and a teacher. Noticeably, too much is asked of libraries - they need to master the new and/or demo robots and satisfy customers' new needs, i.e., the robot must be working like a charm, at the same time. It is unfair to compare a new humanoid robot with an established voice recognition system such as Apple's Siri, Microsoft's Cortana, Amazon's Alexa, and the Google Assistant (Coleman, 2017; Rubin, Chen, & Thorimbert, 2010). They focus solely on natural language recognition and are run on the cloud or on an established device such as a smartphone, a laptop or a computer. On the other hand, a humanoid robot is a piece of equipment with arms, legs, eyes and other body parts which all have to 'work' in a social environment that requires not only an ability to hear and talk, but also to see, sense, and interact emotionally. For this reason, librarians must be resilient. Being an early adopter, they chose to get in front of changes and not just respond to those changes (Bourg, 2017).

RECOMMENDATIONS

In order to develop guiding principles for Australian public libraries to plan and employ humanoid robots, it is recommended that:

(1) Public libraries (in collaboration with their parent organisation, i.e., city councils), devise a strategic plan for new and emerging technologies such as humanoid robots. This will put both the library and librarians in a position that can oversee the entire process of planning, employing and evaluating the effect of humanoid robot programs. It also allows libraries and librarians to align themselves with the direction and vision of the council.

(2) Public libraries seek to expand their collaboration with other stakeholders, such as universities and robotics centres where there are roboticists. As these robotics experts often seek collaboration with external partners, libraries may be one of their ideal community settings to implement social robots. Such a collaboration would bring in dual benefits for both. It not only helps develop librarians' capabilities in mastering robots, but also provides roboticists with opportunities to have their robots work in a library – a centre for life-long learning.

(3) Public libraries and city councils strengthen their relationships with robot vendors in order to take advantage of direct support from them. They should be leading experts in the field who understand details about their robots. The relationship also helps vendors receive invaluable feedback from librarians who directly plan and run robot programs so that they can further improve their products and make them more valuable to the community.

(4) Library management boards and their librarians keep a good line of communication, especially issues related to humanoid robots. This allows management to understand what is happening in the practice, so they can act accordingly. They can also better devise a professional development plan to increase librarians' capabilities in this emerging technology area.

(5) The community and other stakeholders consider humanoid robots in libraries as a work-in-progress. Humanoid robots are a representation of new technologies. They may be a 'beta version' forever, so people should not expect them to be a perfect product. Libraries can help the community to be aware of such expectations via their communication channels. Such an understanding will in turn strengthen the relationship between libraries and patrons.

CONCLUSION

This research has presented fresh insights about the impact of humanoid robots on Australian public libraries. The research findings were drawn from the lived experiences of librarians who directly plan and deploy humanoid robot programs and from direct observations of interactions between the robots and their audience. The findings could inform the development of such robotic programs in libraries to enhance the experience of library user communities.

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From: Human Ethics Advisory Team
To: Linh Nguyen
Cc: Human Ethics Advisory Team
Subject: Ethics application - approved - 1800000317
Date: Thursday, 21 June 2018 9:55:03 AM

Dear Dr Linh Nguyen
Ethics Category: Human - Negligible-Low Risk
UHREC Reference number: 1800000317
Dates of approval: 21/06/2018 to 21/06/2020
Project title: An investigation of humanoid robots and their implications for Australian public libraries

Thank you for submitting the above research project for ethics review. This project was considered by Chair, Queensland University of Technology (QUT) Human Research Ethics Committee (UHREC) or a Faculty-based low risk review panel.

We are pleased to advise you that the above research project meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and ethics approval for this research project has been granted on behalf of the UHREC, to be ratified at their next scheduled meeting.

Approval of this project is valid as per the dates above, subject to the following conditions being met:

< The Chief Investigator (CI) / Project Supervisor (PS) will immediately report anything that might warrant review of ethical approval of the project.

< The CI/PS will notify the UHREC of any event that requires a modification to the protocol or other project documents and submit any required amendments in accordance with the instructions provided by the UHREC. These instructions can be found at http://www.orei.qut.edu.au/human/.

< The CI/PS will submit any necessary reports related to the safety of research participants in accordance with UHREC policy and procedures. These instructions can be found at http://www.orei.qut.edu.au/human/.

< The CI/PS will report to the UHREC annually in the specified format and notify the UHREC when the project is completed at all sites.

< The CI/PS will notify the UHREC if the project is discontinued at a participating site before the expected completion date, with reasons provided.

< The CI/PS will notify the UHREC of any plan to extend the duration of the project past the approval period listed above and will submit any associated required documentation. Instructions for obtaining an extension of approval can be found at http://www.orei.qut.edu.au/human/.

< The CI/PS will notify the UHREC of his or her inability to continue as CI/PS including the name of and contact information for a replacement. This email constitutes ethics approval only.

If appropriate, please ensure the appropriate authorisations are obtained from the institutions, organisations or agencies involved in the project and/or where the research will be conducted.

The UHREC Terms of Reference, Standard Operating Procedures, membership and standard forms are available from: http://www.orei.qut.edu.au/human/manage/conditions.jsp.

Should you have any queries about the consideration of your project please contact the Research Ethics Advisory Team on 07 3138 5123 or email humanethics@qut.edu.au.

We wish you every success in your research.

Research Ethics Advisory Team, Office of Research Ethics & Integrity
on behalf of the Chairperson, UHREC
Level 4 | 88 Musk Avenue | Kelvin Grove
+61 7 3138 5123 humanethics@qut.edu.au
The UHREC is constituted and operates in accordance with the National
Statement on Ethical Conduct in Human Research (2007) and registered by the
National Health and Medical Research Council (# EC00171).

QUT	
	SAMPLE EMAIL APPROACH
An investigation of humanoid robots and their implications for Australian public libraries. **QUT Ethics Approval number 1800000317**	
Research team contacts	
Principal Researcher:	**Dr Linh Nguyen, Associate Lecturer** **Science and Engineering Faculty** **Queensland University of Technology (QUT)**

Subject: Participate in a research on humanoid robots in libraries.

Dear [insert name of the head of library here]

My name is Linh Nguyen from the School of Information Systems, Queensland University of Technology (QUT) and I'm conducting a research project in the use of humanoid robots in Australian public libraries.

I am looking for (1) librarians who are in charge of library programs and services using humanoid robots and (2) library users who use those programs and services to participate in an individual interview. I would like to request your support by encouraging your librarians to join an interview and circulating the attached Recruitment Flyer among attendants of the "robots @ your library" sessions so they can be aware of the research and they can be invited (or contact me directly if they wish) to participate in an interview.

Please view the attached Participant Information Sheet and Consent Form for further details on the study. If you are interested in participating or have any questions, please contact me via email. Please note that this study has been approved by the QUT Human Research Ethics Committee (approval number 1800000317).

Many thanks for your consideration of this request.

Dr. Linh Nguyen
Associate Lecturer
School of Information Systems,
Science and Engineering Faculty, Queensland University of Technology,
07 3138 9103
lc.nguyen@qut.edu.au

QUT	**INTERVIEW QUESTIONS AND PROTOCOL**

An investigation of humanoid robots and their implications for Australian public libraries.   **QUT Ethics Approval number 1800000317**
Research team contacts
Principal Researcher: **Dr Linh Nguyen, Associate Lecturer**   **Science and Engineering Faculty**   **Queensland University of Technology (QUT)**

I.   **Checklist of resources for interviews**
- Audio recorder, pens and notebooks.
- Copies of Participant Information Sheet and Consent Form.

II.   **Procedure of interviews**

     1. **Getting started**

- Researcher introduces self.
- Thanks participant for participating in the interview.
- Briefly explains what the study is about.
- Explains that the interview is confidential. The participant identity will remain anonymous. The participant can leave any time.
- Asks the participant if there is any question.

     2. **Interview questions**

The following interview questions are indicative of type of questions that will be used:

- Can you please briefly tell me about your role in the library?
- As a librarian, can you tell me about the way your library uses humanoid robots in designing and delivering library programs and services?
- What have been the key achievements in using the humanoid robot for your library?
- What have been the main challenges for the use of humanoid robot at your library?
- What do you think about the future of humanoid robots in libraries?

III.   **Summary**

- State what will happen next in the research process and the availability of results.
- Questions and answers.
- Thanks participant.