# Robots Conquering Local Government Services

## A Case Study of Eldercare in Denmark

Nielsen, Jeppe Agger; Andersen, Kim Normann; Sigh, Anne

*Document Version*
Accepted author manuscript

*Published in:*
Information Polity

*DOI:*
10.3233/IP-160381

*Publication date:*
2016

*License*
Unspecified

*Citation for published version (APA):*
Nielsen, J. A., Andersen, K. N., & Sigh, A. (2016). Robots Conquering Local Government Services: A Case Study of Eldercare in Denmark . *Information Polity*, *21*(2), 139-151. https://doi.org/10.3233/IP-160381

# Robots Conquering Local Government Services: A Case Study of Eldercare in Denmark

**Jeppe Agger Nielsen, Kim Normann Andersen, and Anne Sigh**

Journal article (Post print version)

**CITE:** Robots Conquering Local Government Services: A Case Study of Eldercare in Denmark. / Nielsen, Jeppe Agger; Andersen, Kim Normann; Sigh, Anne. In: Information Polity, Vol. 21, No. 2, 2016, p. 139-151.

The final publication is available at IOS Press through http://dx.doi.org/10.3233/IP-160381

# Robots conquering local government services:

# A case study of eldercare in Denmark


## Abstract

The movement of *robots* from the production line to the service sector provides a potentially radical solution to innovate and transform public service delivery. Although robots are increasingly being adopted in service delivery (e.g., health- and eldercare) to enhance and in some cases substitute labour-intensive services, the public administration research community is short on knowledge of the impact on the work processes carried out in public organizations and how staff and clients react toward robots. This case study investigates the implementation and use of robot vacuum cleaners in Danish eldercare, demonstrating how robot vacuums have proven to have considerable interpretive flexibility with variation in the perceived nature of technology, technology strategy, and technology use between key stakeholders in eldercare.

## Introduction

The study of information and communication technology (ICT) in public administration has evolved along the adoption of computer-based technologies from studies in the late 1960s on computing in local government planning processes [1], power and politics in the 1970s and early 1980s [2], and one-stop services, e-government, and information polity studies in the 1990s and beyond [3,4,5]. We take the position that the research community must (start) to pay attention to robots and the other technologies involved in what has been called the second machine age [6,7], which is about to be adopted by local government services and core public administration functions.

For decades, robot technology has been heralded as bringing about fundamental changes to the industrial work environment [8]. Prominent economists such as Erik Brynjolfsson have argued that robots will transform work processes and bring about productivity increases [9,6]. Advances in robot technology also appear to offer an alternative to traditional labour for providing routinized tasks and services in public sector health and eldercare [10,11,12,13]. This includes research on services and socially assistive robots [14,15] and robots for re-training and assisting patients in their own homes rather than receiving such help in hospitals or rehabilitation centres [16].

While robot use is increasing and high expectations to robots are bringing about a radical shift in *automation and simpler* government (e.g., [17]), empirical knowledge about the interplay with physical work processes and how key stakeholders react towards robots is sparse. Our position is that the lack of research regarding robot use is a serious gap in public administration literature and a failure to explore what could become a major game changer in public service delivery. We

have followed the uptake of robot vacuum cleaning from early on (e.g., [18]), armed with organizational and public administration literature on what we view as a growing and stimulating field of technology use in the public sector.

This paper uses the concepts of technological frames [19] and 'interpretive flexibility' [20,21] to explore how the critical stakeholders in local government eldercare in Denmark perceive and make sense of robot vacuum cleaners as they have been applied in everyday practices. More specifically, we explore (a) how interpretive flexibility manifests through the perceptions of key stakeholders involved in the implementation of robot vacuum cleaners, and (b) what are the advantages and pitfalls of using robot vacuums from the perspective of key stakeholder groups?

To investigate the research questions, we rely on a qualitative, single-case study [22] from a Danish municipality (Billund) that has deployed robot vacuum cleaners in government-funded eldercare services. In 2011, Billund Municipality introduced robot vacuum cleaners as a substitute for traditional vacuum cleaners in eldercare, now involving almost 400 robot vacuums. Billund has been a first-mover in the enforced adoption of robot vacuums in Denmark. It is a comprehensive initiative with many robots in use, now beyond a pilot test, and Billund has served as an inspiration for other municipalities. Thus, our case may serve as an appropriate unit of study, making it possible to obtain information in a rather unusual case setting [23] that could be of inspiration for researchers and practitioners interested in robot innovation in the public sector.

The paper is organized as follows. In the next section we outline our theoretical framework before presenting the research design and method, followed by an analysis of the implementation

and use of robot technology in Danish eldercare. The concluding section outlines practical and theoretical implications as well as the limitations of our study and recommendations for further research.

## Theoretical lens guiding our case study

The notion that robot technology can make planned changes and deal with impending demographic shifts is manifested in the Danish national IT strategy [24]. Although robot vacuum cleaners may be perceived as a rather fixed artefact, decades of technology-focused research stipulates the malleability of the robot artefact open to interpretation by adopters and observers (e.g., [20]) and is likely to produce unexpected outcomes when implemented by local government organizations with a variety of stakeholders with multiple and often ambiguous objectives [2].

Following Orlikowski and Gash [19], we assume a close relationship between perceptions and actual behaviour; thus, to become productive technologies, robots would require support from the actors involved. We argue that factoring in a client perspective and their interpretations is an adequate extension of the original framework [19] in order to address the advantages and pitfalls of technologies that aim for a direct impact on the service to the citizen. Accordingly, we investigate the perceptions of robot vacuum cleaners among a technologist, managers, frontline staff, and eldercare clients.

Our research is guided by a theory-driven examination of how the actors make sense of a technology in its implementation and ongoing application as they interact with it [25]. Similar approaches have previously been used to address the complexities involved in public sector ICT

implementation (e.g., [26,27]) and robot use in hospital settings [28]. More specifically, we are investigating how underlying assumptions, expectations, and the knowledge that people have about new technology (i.e. technological frames) are crucial to enrich our understanding of technology use and change in organizations as they critically influence how people act around technology [19,20].

Emphasizing the 'interpretive flexibility' of technologies, Orlikowski and Gash [19] divide technological frames into three main categories: *Nature of Technology*, referring to how actors perceive technology, including its suitability and function; *Technology Strategy*, capturing the desired impact supporting organizational goals; and *Technology in Use*, including the actors' understanding of how technology is used and will become important in daily routines. In sum, the three categories 'reflect what the technology is (nature of technology), why it was introduced (technology strategy), and how it is used to create various changes in work (technology in use)' [19, p. 184]. The three categories are our analytical tool for assessing similarities and differences in how actors understand technology. Moreover, technological frames are flexible in nature, as perceptions of a given artefact may change over time [19,29].

Orlikowski and Gash [19] identify three vital groups in technology implementation: technologists, managers and users. *Technologist* key interest captures a technical understanding of technology, where technology is seen as a tool to be designed and perform a given task. *Manager´s* key interest refers to strategic understanding of technology whereby the expectations typically associated with the new technology will change the workflow, thus providing a financial return or improve services. *User* interest refers more to an instrumental understanding

of technology, the expectation being that technology use provides an immediate return in the form of revised and easier workflow.

Shared technological frames denote an agreement on how to use technology; for example, similar expectations concerning the role of technology in business processes and the nature of technology use [19]. In a conflict situation, however, there are significant differences in terms of the expectations, assumptions, or knowledge about technology, which may have fatal consequences for implementation. Moreover, '…frames can create "psychic prisons" that inhibit learning because people cannot look at old problems in a new light and attack old challenges with different and more powerful tools – they cannot reframe' [19, p. 177].

We propose an extension to the original Orlikowsky and Gash model by *adding a client perspective* in order to study the use of the technology in close physical proximity to the clients and the impact on service delivery. Thus, it seems theoretically critical and valuable to include client interpretations of how technology is expected to improve service delivery. Including this dimension enables the analysis to complement the intra-organizational aspects with client interpretations of robot vacuum cleaners as an essential element in the identification of the opportunities and pitfalls related to robot use. We argue that the client frame of reference refers to an understanding of robot technology whereby expectations relate to how technology can improve the received service and help individuals maintain their independence.

Adding the client dimension to the theoretical lenses, we offer a potential contribution to the vast array of studies that have adopted the Orlikowsky and Gash framework (e.g. [30]). Although the

human–computer interaction studies have addressed the end users, it took almost two decades to include the citizen and/or client perspective in the institutional theoretical lenses.

## Method

### Research setting

The research context of our case study is public sector-provided eldercare in Denmark. The Danish Social Services Act obligates local governments (municipalities) to facilitate the help and support needed by the elderly [31]. Within the legislative umbrella, two forms of eldercare exist: (1) care in municipally owned and *operated assisted living facilities*, and (2) municipality funded *home care* delivered to senior citizens in their private homes. In both settings, personal services (e.g., bathing) and practical services (e.g., cleaning) constitute the core of the delivered services. In Denmark, 118,000 persons receive public-funded practical services such as cleaning, amounting to a total of 87,000 hours each week [32]. In this context, robot vacuum cleaners provide an opportunity to save time.

The Danish eldercare services are predominately provided by municipal employees, although home care recipients can choose private companies for practical and personal care and have the costs reimbursed by their local government. Internationally, Denmark is considered a frontrunner in the area of public-financed eldercare in terms of extensive service provision to the elderly and high per capita spending [33].

Since the mid-1990s, Danish eldercare has increasingly used information and communication technology [34], and robot vacuum cleaners are becoming increasingly integrated in everyday

work [35]. On the political scene, top ministers have praised robots as a means to transform public service delivery and support the available resources with intelligent technology solutions. In sharp contrast, robot vacuum cleaners have been severely criticized by the Danish Association of the Elderly and others who fear that robots undermine personalized services and represent a masked privatization of welfare services [36]. Despite this controversy, the use of robot vacuums has become more widespread and is fully or partially replacing manual cleaning. One report estimated that 66% of the 98 municipalities in 2013 have decided to use robot vacuum cleaners in eldercare [35].

Since 2011, Billund Municipality has systematically used robot vacuum cleaners to substitute manpower. Billund has a population of 26,367 citizens (pr. 1.1.13) and is a mid-sized Danish municipality covering 541 $km^2$. In 2013, 219 clients lived in Billund Municipality assisted living facilities and 583 clients received home care services. When the municipality took the formal decision to acquire robot vacuum cleaners, new standards for cleaning prescribed that the 'municipal standards for vacuuming imply that vacuuming is done by robots' [37]. Accordingly, the allocated time for each home care cleaning visit was reduced by 12 minutes (20%). As part of this strategy, home care clients were told to either buy their own robot, switch to a private provider (using traditional vacuum cleaners) or use the municipality's own robots once every three weeks [38]. Overall, the reduced time allocated to home care due to the introduction of robots has saved the municipality €150,000 annually.

Table 1. Home care clients with and without robots in Billund Municipality. 2013.

| | N | Percent (%) |
|---|---|---|
| Home care clients who *have invested* in a robot vacuum cleaner | 377 | 65 |
| Home care clients who *use the municipality's* robot vacuum cleaner | 4 | 1 |
| Home care clients who are approved for *traditional vacuuming* | 37 | 6 |
| Home care clients who receive home care from *private providers* (not using robots) | 165 | 28 |
| Total recipients of home care (including cleaning) | 583 | 100 |

As shown in Table 1, most (65%) clients have chosen to invest in a robot themselves (as recommended by the municipality). The cost of the robots are in the range USD 200 to USD 600 depending of the model. The most common robots costs about USD 250. Interestingly, very few (1%) have chosen to make use of the municipality's robots. However, 165 (28%) clients prefer a private provider that does *not* use robots. In the wake of the introduction of robots, more than 70 clients immediately shifted from the municipal service to a private provider to avoid the robots. Those opting for a private provider had to pay a €7 user fee for each vacuuming. Accordingly, home care clients in Billund are not forced to buy a robot vacuum cleaner themselves, as they are able to continue with vacuum cleaning provided by the municipality every second week using robots owned by the municipality or switch to a private provider (with a user fee). The municipality has pushed strongly for home care clients to invest in their own robots, however, and the question is whether clients experience a real freedom of choice in this regard. Residents in assisted living facilities are not expected to buy their own robots. Instead, Billund Municipality has replaced traditional vacuum cleaners with 12 robots (iRobot) for cleaning in assisted living facilities.

**Data collection**

The case study was designed to emphasize the perceptions of key stakeholders and we therefore adopted an interpretive, qualitative mode of inquiry to capture sensitively the social phenomena under investigation. We conducted 18 semi-structured interviews in 2012 and 2013 with four key stakeholder groups: the managers of social service, eldercare, and operation management (3); the IT-manager (1); care workers in assisted living facilities (3) and in home care (4); and clients living in assisted living facilities (3) and in their own houses (4). The interviews took about 1–2 hours each and were conducted at the workplace or the clients' home. All of the interviewed clients were between 70 and 80 years old, thus representing the elderly recipients of eldercare services (but not capturing the service users among the younger age groups). The interviews were subsequently transcribed in full length to facilitate analysis.

The interviews were supplemented with the analysis of a number of documents, including project descriptions and minutes from meetings, to gain further insight into the formal aspects of the implementation process. Finally, we used observation techniques as we followed care workers 'at work' with robots to better understand their use in everyday practice. These observations took place over two mornings (May 2012) in two assisted living facilities and were documented using field notes. The field observations supplement the interviews in terms of how robot vacuums are used in practice, thereby challenging or reinforcing the findings from the interviews.

To make sense of this data from different social groups, we first read through the collected data material (i.e. transcribed interviews, documents and field notes) to get an overview of the entire material [39]. Next, our inductive data analysis was more directly linked to our research question and theoretical framework. Accordingly, Orlikowski and Gash's [19] technology frame concept

was particularly inspiring for our coding and structuration of data, focusing on the nature of robot innovation, strategies, and robots-in-use. Finally, we asked two managers from Billund Municipality to comment on our findings to ensure that we had accurately captured what they said. This process produced useful feedback and a number of factual matters were corrected.

## Analysis

### Nature of technology

The Billund managers were enthusiastic about robot innovation as a promising way to modernize eldercare. They were confident that robots could cut costs and clean just as well as traditional vacuums. They also stressed how the cost of acquiring the robots was affordable for clients and that their being able to vacuum as often as they like represented an important improvement (as opposed to every third week, which they had been approved for). One manager noted:

> *It's a win-win situation. We can save money while the citizens receive good service. In my opinion they get vacuumed just as well with the robots.*

This optimistic view was generally echoed by technologists (as assumed by Orlikowski and Gash [19]. The IT manager saw robots as an obvious means to transform service delivery. Similarly, robot suppliers also praised the new technology. One of the suppliers wrote:

> *A robot vacuum cleaner does exactly what it promises – it vacuums automatically so you don't need to. With a robot vacuum cleaner you free up time for other work. The robot does a thorough job and gets completely into the corners* (www.roboteksperten.dk).

As we turned to the other stakeholder groups, however, incongruence in the technological frames between groups became clear. In contrast to the optimistic perspectives of the managers and technologists, the frontline staff and eldercare clients had more mixed views on the robots. In particular, the staff initially had a somewhat negative attitude towards the robots. A care worker explained:

> *In the beginning there was nobody who cared about this new, odd thing. The staff would rather vacuum the old way so that we get into the corners!*

Although scepticism seemed to wane over time, the debate on robots continued. One care worker noted:

> *There are both good and bad things about robots, and there are very different opinions on them. But they're probably here for good.*

The care workers highlighted numerous benefits from using robots but also reported feeling pressed for time, as each visit was reduced by 12 minutes:

> *It's efficient for us – to be able to start the robot and do other things at the same time. The robot might not get all the dirt in the corners, but it gets most of it.*

The staff also mentioned how the robots improved the physical work environment. As one care worker commented:

> *It's not as hard on my back. I don't get worn out when I can rely on the robot. I think that's a good thing.*

Similarly, eldercare clients had different and sometimes conflicting views on robots. In particular, they were not happy about having to buy robots themselves. A client noted:

> *And we even had to buy the robot ourselves … Yes, I thought it was a change for the worse.*

The clients who were interviewed also commented on the social dimension. As already mentioned, the introduction of the robots meant that each client visit was cut by 12 minutes. While 12 minutes might not sound like much, it seems to have had an impact on some of the clients, who miss the time they used to have with the frontline staff. In this sense, some clients saw robots as a technology that undermines personalized services. At the same time, however, they appreciated being able to vacuum as often as they like.

**Strategy**

Our findings regarding the municipal technology strategy also show that different (organizational) roles and interests suggest different technological frames. Top managers had a clear vision of the benefits that robots could provide, and the economic constraints provided a key motivation for adopting the robots:

> *For the municipality it's crucial to ensure effective care for clients. We have to support the available resources with intelligent technological solutions* [38].

The top managers not only praised robot innovation, they also considered the implementation process as a success in which frontline staff were deeply involved. The managers emphasized how the demand for robot usage originated within the frontline staff themselves. The eldercare manager said:

> *A committee of eldercare managers and employees prepared a proposal in 2010 for the politicians to cut costs. One of the suggestions implied that robots could ensure savings of about €150,000 annually. So the frontline staff representatives themselves actually helped suggest robots as a good idea.*

She further argued that the resistance and scepticism about robots have been limited. In her view, both the municipality in general and frontline staff in particular were ready for change. Moreover, the fact that the idea to use the robots originated 'from below' has helped legitimate their use:

> *We're privileged to have employees who are ready for this. But I also think it's because it actually comes from their needs. We don't say you have to do this or that. Obviously, we've soften them up a little. But we've framed it in such a way that it's about their ideas and needs. They have a lot of say.*

A noticeable initiative in the involvement of frontline staff during implementation has been education from assisted living technology *ambassadors*. According to the top managers, these ambassadors played a crucial role in reducing the resistance towards change – '*they've been able to sell the idea of robot innovation to their colleagues*', as one manager commented. Hence, these ambassadors turned out to be useful means to achieve improved mutual understanding and consensus among stakeholders. While assisted living technology ambassadors played a crucial role in the introduction of the robot vacuum cleaners, it is worth noting that the IT department was not involved. The IT department felt that it was unnecessary for them to get involved, and the eldercare managers also found it unnecessary to involve the IT department. Any questions of a technical nature were directed towards the robot suppliers.

While the top managers considered the implementation process a success throughout which employees were deeply involved, the frontline staff viewed the early phase differently. In fact,

the interviewed frontline staff agreed that the decision to introduce robot vacuum cleaners came as a surprise. They were especially frustrated by the lack of information. One care worker said:

> *Well, we got a bit of a shock with the robot vacuum cleaner … In fact, everyone else knew about it before we did.*

The frontline staff did not feel they were informed about using robot vacuum cleaners in their daily work but felt more involved and better informed in the later stages of the implementation process. The assisted living technology ambassadors were designated immediately after the introduction of the robot vacuum cleaners, which was possibly a wise move by management in their effort to improve congruence in the frames across stakeholder groups. Indeed, the frustrations over the lack of involvement and information that had arisen from the start were improved with the assisted living technology ambassador initiative.

The clients who were interviewed represent somewhat mixed views regarding the information about the introduction of the robot vacuums. A client said:

> *We were only told that we should have robots, and that they* [the municipal staff] *should not vacuum for us anymore. That's all we were really told.*

The municipality, however, conducted several information sessions early in the process for clients and relatives to answer urgent questions and raise emerging concerns about the robot vacuum cleaners. Besides serving the obvious informative purpose, the information sessions also made the municipality aware of possible criticisms from clients.

**Use**

A crucial aspect of using robot technology is having sufficient knowledge to operate the device efficiently. Such knowledge is typically acquired through training and education [19]. In Billund, however, the managers decided to cut the amount of formal education and training provided to frontline staff. There appear to have been at least three reasons for doing so: Firstly, robots were seen as a simple technology that could be learned and used by frontline staff (and clients) with relative ease. Secondly, the municipality assumed that traditional training programs were unnecessary, as the clients themselves purchased the robots. Thirdly, the eldercare managers emphasized that it is through use and experimentation, rather than formal education, that people learn to operate and appreciate the robots. One manager commented:

> *It was most beneficial when the staff were allowed to take the robots to their own homes and try them out. In fact, they became super salesmen towards the citizens. It was the right strategy … And then we have assisted living technology ambassadors in our organization who are enthusiastically helping to implement new technology – not just robots – in the best possible way in eldercare.*

A care worker agreed:

> *The opportunity to try out the robots in our own homes really resulted in more positive views towards robots.*

These quotes illustrate how the perceptions of robot technology among frontline staff change as they interact with it [19]. In fact, testing the robots ensured a more positive approach towards the new innovation. In this way, managerial intervention appears to have helped frontline staff to reframe their understandings associated with the robots.

Evidence from our case site illustrates that robots were in daily use. However, robot vacuum cleaners did not always completely replace the traditional vacuum cleaners. Instead, frontline staff (especially in assisted living facilities) sometimes continued to use traditional vacuums. A manager at the operational level remarked:

> *Most staff have accepted the robots. But some are still using the traditional vacuum cleaner … I have employees who refuse to use robots.*

This sentiment was echoed by the frontline staff. A care worker employed in an assisted living facility noted:

> *We use robots, but we also still use the traditional vacuum cleaner just as we did earlier. We use robots in the dining room but not in the corridors, because residents are always walking around.*

Consistent with these views, our field observations in assisted living facilities illustrated some of the difficulties related to robot use. For instance, the basic task of emptying the robot appeared to be a cumbersome activity, and staff explained that the residents would never start the robots themselves. Moreover, using the robots required more planning and preparation than anticipated. For instance, furniture must be removed before robots can be used effectively. One care worker observed how robot use must also be tailored to other services:

> *When we turn on the robot we have to be completely finished with the morning care because we can't have the robot going while we're running back and forth to provide care. It requires more planning than we expected.*

Whereas the robots in assisted living facilities function as a supplement to traditional vacuuming, they are more readily seen as a replacement in home care (at least from a frontline perspective). The interviewed care workers agreed that robots are systematically used in home care services.

This difference in robot use between assisted living facilities and home care might be surprising. In any case, assisted living facilities have larger, more regular floor surfaces, and are therefore likely to be more suitable for robots than smaller, private homes.

Comparing the interpretations of the care workers and clients, a clear image of interpretative flexibility emerges. The home care clients regarded the robots as a supplement to traditional vacuums rather than a replacement. Hence, most of the clients interviewed have also invested in a handheld vacuum cleaner for furniture. The general reaction is that robot vacuum cleaning gets most of the dirt but that they do not get into the corners. As one client explained:

> *There are so many different opinions in favor and against robots. Many first believed that they would replace our conventional vacuum cleaners – but that's certainly not the case. They're only a supplement, because we can't do without the other vacuums for furniture and other things.*

In Table 2, we have summarized our analysis and illustrated the different interpretations of robot technology. Rows are mapped to the phases analysed, and columns to the four sets of actors interviewed (managers, technologists, frontline staff, clients).

**Table 2. Overview of views on robot vacuum cleaners among managers, technologists, frontline staff, and clients (nature of technology, strategy, and use)**

| | Managers | Technologists | Frontline staff | Clients |
|---|---|---|---|---|
| Nature | Enthusiastic about the robots. Consider robot innovation as a win-win situation (savings and better services). | Enthusiastic about the robots as an obvious means to transform service delivery. | Mixed perceptions. Some saw robots as a new, 'odd thing', others saw them as useful for improving cleaning standards. | Mixed perceptions. Some found that the robots do not clean properly, others appreciate that they can now vacuum as often as they like. |

| | | | | |
|---|---|---|---|---|
| Strategy | Cost savings as a key motivation. Force/ encourage clients to pay for the robots themselves.<br><br>Participatory implementation model with assisted living technology ambassadors. | The IT department found it unnecessary to be involved in the implementation process, as they were perceived as a simply technology. | Aware that robots were introduced to cut costs, but their main motivation is to improve their working conditions.<br><br>Consider the implementation of robots as a top-down process in which they have little influence and lack information, especially in early phases. However, assisted living technology ambassadors see them as a useful initiative. | Some see the robots as supporting staff while others see it as clear-cut savings manoeuvring. Lamented that they have to buy the robots themselves. |
| Use | Robots seen as replacing traditional vacuums. However, managers recognize that care workers sometimes still use traditional vacuums. | Robots viewed as a simple technology that is easily integrated in everyday working practices. | Robots are in daily use. In home care, the staff perceive the robots as replacing traditional cleaning. In assisted living facilities, staff see robots as a supplement for traditional cleaning. | Seen as a supplement to traditional vacuum cleaners, not a replacement. Clients feel that robots do not get into the corners well. |

**Discussion of findings**

The varying interpretations of new robot technology among the respective stakeholder groups based on their interactions with robots is illustrative of the interpretative flexibility [19,20] in robot technology. Technologists and managers praise the new innovation for cutting public costs and being affordable for clients, while attitudes towards robots are more varied among care workers and clients. The clients lament having to buy the robots themselves and found that they do not clean properly. Some shifted from local government-provided service to a private provider to avoid using robots (Table 1). Some care workers even persist in traditional vacuuming.

Resistance to change is common when new technologies are introduced [40], and assisted living technologies (such as robots) may be an especially sensitive point for frontline staff, since this type of technology can eventually make them redundant. This may help explain the conflicting

attitudes towards robots among care workers. Moreover, while the robot vacuum is a relatively mature technology, interviews with staff and clients alike reveal how technical problems still exist despite this maturity (e.g. difficulties getting into the corners).

Whereas care workers considered the implementation of robots as a top-down process in which they had little influence and lacked information, especially in the early phases, managers regarded it as a participatory process in which employees were engaged throughout. Yet all of the interviewed stakeholders praise the introduction of assisted living technology ambassadors as an appropriate way to support robot implementation. This might help explain why managers succeeded in having care workers use robots more or less as intended (at least in home care services). This leads us to propose that the use of assisted living technology ambassadors is a promising initiative to improve the implementation of fairly unfamiliar technologies such as robots.

We observed striking differences in the practical use of robots between assisted living facilities and home care. In assisted living facilities, the robot vacuum cleaners were merely a supplement to traditional vacuums, while frontline home care staff viewed the robot vacuums as a substitute technology. This view was not shared by the home care clients, who then invested in handheld vacuum cleaners. The variations in working practices and opinions regarding robot technology underscore the interpretative flexibility in robot vacuum cleaning technology. Although these different attitudes towards the nature, strategy, and use of robot vacuum cleaning occasioned outcomes that deviated somewhat from those expected, they did not derail the implementation process.

## Concluding remarks

Our analysis reveals how a technologist, managers, frontline staff, and clients held different views towards robot vacuum cleaning. The technologist and managers praised robot innovation for cutting costs and improving service delivery. By contrast, the frontline staff and clients had mixed perceptions about robots, and some found that robots did not clean the floors properly. Overall, our study illustrates how robots proved to have interpretive flexibility, with differences in the perceived nature of technology, technology strategy, and technology use. Although these differences induced outcomes that deviated somewhat from those anticipated, they did not disrupt the implementation process, adding instead to the ongoing social construction of robot technology as they entered eldercare.

The case examined in this article represents a modernization effort in Danish local government eldercare where robots have been introduced and widely used in daily practices to transform service delivery. Accordingly, insight into what happens when robot technology is applied in such an early adopter setting could be an indicator of similar effects that might arise in other settings and countries [41]. While the vacuuming robots represents a rather specific case, the paper explores actor constructions regarding robot technology that may help researchers and practitioners better understand how and why different stakeholders are likely to use robots and with what (anticipated and unplanned) consequences in particular settings.

By placing technological frames [19] at the heart of understanding robot innovation we have detailed how critical stakeholder groups (technologist, managers, frontline staff, and clients) have different perceptions towards robot vacuum cleaning. In this sense, we see how different groups perceive the same robot differently, which demonstrates the interpretive flexibility in

robot innovation with differences in the perceived nature of technology, technology strategy, and technology use. We have also offered an adequate extension of the original technological frame model [19] by factoring in a client perspective. This is particularly relevant to take into consideration, as public sector technologies are increasingly moving from the back offices to front-line workers and clients, as illustrated in this paper.

The findings we have presented in this article call for further research regarding other types of robots and work environments. Examining other kinds of robot technologies may very well offer different properties than those generated by robot vacuum cleaners. Also, investigating different countries (e.g., in North America or Asia) and institutional settings (e.g., teaching robots in elementary schools or service robots in health care) to those studied here would also expand our understanding of how critical stakeholders make sense of and use robots with particular consequences for organizations and individuals. We have presented results from a single case study based on relatively few interviews with citizens and staff. Clearly, future research could include large-scale studies on robot innovation and ideal time-series data material to investigate possible learning curves for robot use and whether the perception imbalances among the three groups of respondents change over time as experience with the technology moves beyond the initial stages towards a routinized phase.

As studies on the application of robot technology in public service delivery are more likely to use technology acceptance models as a theoretical framework [42], we observe the need for organizational and public administration-oriented research on this emerging research topic: given the number of robot technologies entering labour-intensive public services, we suggest more

research to be done in this area. With this paper, we have got the ball rolling and urge the public administration research community to pick it up and engage further in exploring the role of robots in public service delivery.

## References

[1] Weiner ME. Service: the objective of Municipal Information Systems. Institute of Public Service, University of Connecticut; 1969.

[2] Danziger JD, Dutton WH, Kling R, Kraemer KL. Computers and politics: high technology in American local governments. New York: Columbia University Press; 1982.

[3] Taylor JA. Williams H. Public administration and the information polity. Public Admin. 1991;69(2):171-90.

[4] Norris D, Moon MJ. Advancing e-government at the grassroots: tortoise or hare? Public Admin Rev 2005;65(1):64-75.

[5] Pollitt C. New perspectives on public services: place and technology. Oxford University Press; 2012.

[6] Brynjolfsson E, McAfee A. The second machine age: work, progress, and prosperity in a time of brilliant technologies. New York: W.W. Norton & Company; 2014.

[7] Ford M. Rise of the robots: technology and the threat of a jobless future. New York: Basic Books; 2015.

[8] Engelberger J. How robots lost their way. Businessweek, November 30, 2003.

[9] Brynjolfsson E, McAfee A. Race against the machine: how the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the

economy. The MIT Center for Digital Business; 2012. http://ebusiness.mit.edu (accessed April 9, 2014).

[10] Mutlu B, Forlizzi J. Robots in organizations: workflow, social, and environmental factors in human–robot interaction. Proceedings of HRI08. New York, NY: ACM Press; 2008. p. 239-48.

[11] Broadbent E, Kuo IH, Lee YI, Rabindran J, Kerse N, Stafford R, MacDonald BA. Attitudes and reactions to a healthcare robot. Telemed J E Health. 2010;16(5):608-14.

[12] Liebert MA. No longer rocket science: robots have found their place in healthcare. Telemedicine and e-Health. 2011;17(6):409-14.

[13] Compagni A, Mele V, Ravasi D. How early implementations influence later adoptions of innovation: social positioning and skill reproduction in the diffusion of robotic surgery. Acad Manag J. 2015;58(1):242-78.

[14] Sparrow R, Sparrow L. In the hands of machines? The future of aged care. Minds and Machines. 2006; 16, 141–61.

[15] Banks MR, Willoughby LM, Banks WA. Animal assisted therapy and loneliness in nursing homes: use of robotic versus living dogs. J Am Med Dir Assoc 2008;9:173-7.

[16] Östlund B, Olander E, Jonsson O, Frennert S. STS-inspired design to meet the challenges of modern aging: welfare technology as a tool to promote user driven innovations or another way to keep older users hostage? Technological Forecasting and Social Change 2015;93:82-90.

[17] Sunstein CR. Simpler: the future of government. Simon & Schuster; 2013.

[18] Andersen KN, Gimple G, Medaglia R, Sjølin P, Mikkelsen LS. Robots on the move from the production line to the service sector: the grand challenges for contractors, workers, and

management. eChallenges 2010. Warsaw, Poland. eChallenges e-2010 Conference Proceedings. ed./P. Cunningham; M. Cunningham.

[19] Orlikowski WJ, Gash DC. Technological frames: making sense of information technology in organizations, ACM Transactions on Information Systems. 1994;12(2):174-207.

[20] Pinch TJ, Bijker WE. The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might benefit each other. Soc Stud Sci. 1984;14(1):399-441.

[21] Lohan M. Constructive tensions in feminist technology studies. Soc Stud Sci. 2000;30(6):895-916.

[22] Stake RE. The art of case study research. Sage: Thousand Oaks; 1995.

[23] Flyvbjerg B. Five misunderstandings about case-study research. Qual Inq. 2006;12(2):219-45.

[24] Ministry of Finance (2013). Digital velfærd – en lettere hverdag. Fællesoffentlig strategi for digital velfærd 2013-2020 [Digital welfare – an easier everyday. Collective putlic strategy for digital welfare]. Copenhagen: The government, Local Government Denmark and Danish Regions. URL http://www.digst.dk/Digital-velfaerd/~/media/Files/Velf%C3%A6rdsteknologi/Strategi%20for%20digital%20velf%C3%A6rd/digital_velfaerd.pdf (accessed November 11, 2015).

[25] Weick KE. Sensemaking in organizations. Sage: Thousand Oaks; 1995.

[26] Fountain JE. Building the virtual state: information technology and institutional change. Washington, DC: Brookings Institution; 2002.

[27] Bekkers V, Homburg V. The information ecology of e-government revisited. In: Bekkers V Homburg V, editors. The information ecology of e-government: e-government as institutional and technological innovation in public administration. Amsterdam: IOS Press; 2005. p. 183-92.

[28] Siino RM, Hinds PJ. Robots, gender and sensemaking: sex segregation's impact on workers making sense of a mobile autonomous robot. Stanford. URL http://www.stanford.edu/~phinds/PDFs/Siino-Hinds-2005.pdf
(accessed November 11, 2015)

[29] Orlikowski WJ. Using technology and constituting structures: a practice lens for studying technology in organizations, Organ Sci. 2000;11(4):404-28.

[30] Lin A, Silva L. The social and political construction of technological frames. Eur J Inf Syst. 2005;14:49-59.

[31] Ministry of Social Affairs. Consolidation act on social services; 2010. URL http://english.sm.dk/ministryofsocialwelfare/legislation/social_affairs/social_service_act/Sider/Start.aspx (accessed November 11, 2015).

[32] Nielsen JA, Andersen JG. Hjemmehjælp som spareobjekt [Home care as object for savings]. Gerontologi. 2014;30(1):26-31.

[33] Doyle M, Timonen V. Home care for ageing populations: a comparative analysis of domiciliary care in Denmark, the United States and Germany, Northampton, MA: Edward Elgar; 2007.

[34] Nielsen JA, Mathiassen L, Newell S. Theorization and translation in information technology institutionalization: evidence from Danish home care. Manag Inf Syst Q. 2014;38(1):65-86.

[35] KL. Robotstøvsugere er blevet en del af hverdagen. KL Momentum, January 28; 2013

[36] DaneAge. Robotter skal erstatte hjemmehjælpen [Robots replace home care]; 2012. URL https://www.aeldresagen.dk/presse/nyheder/Sider/robotter-skal-erstatte-hjemmehjaelpen.aspx?emne=Teknologi+og+IT (Accessed November 11, 2015).

[37] Billund Municipality (n.d.) Kvalitetsstandarder, hjemmeplejen kvalitetsstandard [Quality standards, home care quality standard] III + IV. Billund Municipality, Denmark.

[38] Billund Municipality (Project description n.d), internal document, Billund Municipality, Denmark.

[39] Miles MB, Huberman AM, Saldaña J. Qualitative data analysis: a methods sourcebook. 3rd ed. Los Angeles: SAGE Publications; 2014.

[40] Markus ML. Power, politics, and MIS implementation. Communications of the ACM. 1983;26(6):430-44.

[41] Pettigrew AM. Longitudinal field research on change: theory and practice. Organ Sci. 1990;1(3):267-92.

[42] Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. Manag Inf Syst Q. 1989;13(3):319-40.