# The impact of service robotics on service work within a healthcare service system

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*Demographic change nowadays has more and more influences on the health care sector. Less nursing staff face more and more patients and elderly people. Those changes on work processes can be observed in the area of prevention but also in the field of medical and elderly care. Technical support in the sense of IT is considered as helpful to support documentation. Nevertheless, support is still required concerning physical interaction in nursing and elderly care. The proposed solution in the paper at hand describes the potentials of service robotics for complex service systems in healthcare, also describing the mutual influences between the possible applications of service robotics and the changes in service work.*

## 1. About the project “SeRoDi”

The staff in the health care system, especially for nurses for the elderly and in hospital, can benefit from modern robotic technologies. Robotics may disburden them from routine jobs and help at physically exhausting tasks. Currently, nursing staff needs about 20 percent of their working time for jobs which are not about care, but about transporting waste or dirty laundry (cf. Simon et al., 2005). This means that the physical and mental stress is high for the nurses. Through service robotics, this stress can be reduced. Patients and residents can benefit from the use of service robotics as the service robotics may help them in their daily life or give cognitive stimulation.

This situation is the initial position for the research project “SeRoDi” which is an acronym for the German expression for “Service robotics for supporting personal services”. The SeRoDi project is funded by the German Federal Ministry of Education and Research (BMBF). Six project partners (four research institutions and universities, a clinic and a retirement home) work on this project, starting in November 2014 until October 2018.

The project focuses on three topics. One focus is the purchase of automated guided vehicles (AGV) which are already in use in big clinics in particular for transporting food, laundry or waste in areas without patients. These AGV will be further developed and be made to assistants for nurses or patients and residents. Another focus in the project is which consequences the use of such technology has on nurses and patients. It is analysed what the technology means for the working conditions, the workload and support opportunities of the nurses, but also for the quality of care and for the acceptance of technology. The next focus is the service research perspective. It is analysed which part of the service system could be supported by service robotics and how service processes will change. The use of service robotics will have consequences for the productivity and the quality of the work.

This last mentioned focus is the topic of the paper at hand. It raises following questions:

- How does the service system change through the development and use of service robotics?
- How does service robotics influence the interaction in the field of medical and elderly care?
- In which parts of the processes in medical and elderly care are potentials for improvements through service robotics?
- Where and how can the productivity and also the quality be raised?
- Which mutual correlations can be observed between the technological development and configuration of the (modular) service robotics, the service work and the design of the overall service system?

These questions should be answered during the project span. This paper deals with a first insight in some of these questions.

# 2. Methodology

First of all, it had to be decided which kind of service robotics in the form of a mobile care assistant should be tested in the involved clinic and in the retirement home. Additionally, it was important to get first insights in a typical workday, in the service processes and in the use of the originally, non-automated medical trolleys, as these should be transformed to automated guided vehicles. In order to find this out, a three day visit for the research partners in the clinic and the retirement home was organised, followed by feedback workshops.

As a next step, the service robotics are being developed, which will be ready for a first test use in January 2016. In order to be able to compare the work situation and the service processes before and after the use of the service robotics, a set of surveys is necessary. These service instruments are being developed and discussed with the clinic and retirement home. The surveys will be conducted in autumn 2015.

One part of these surveys will be the so called “three component model”, which is a process modelling method developed by the Fraunhofer Institute for Industrial Engineering (Fraunhofer IAO) and the University of Greifswald. This method will help by analysing the service processes and by designing them new.

In the following sub-chapters, the steps are described in detail.

## 2.1. Visits in and workshops with the involved clinic and retirement home

To get a first insight in the service processes and in the use of the medical trolleys the research partners visited the clinic and the retirement home for three days in spring 2015. In teams of two persons the research partners accompanied the nurse

staff during their shifts. Like this, in the two facilities of the retirement home and in the involved ward in the clinic different shifts (early, late and night shift) were accompanied. The researchers were especially interested in finding out how much time is needed for the care, for administration or documentation, for transport and logistics etc., and which distances the nurses have to go in order to fulfil their jobs. For this purpose, the researchers had tablet PCs with an app ("ATracker") with categories for different tasks where they could indicate the duration and the kind of tasks and add additional notes if necessary. This kind of documentation was not systematically and stringent, but should just be an assistance to note the first impressions. The tasks which were installed in the app belonged to different categories:

- Autonomous tasks: Tasks which are done by the service giver (here: the nurse), e.g.:
    - Documentation
    - Communication to other persons
    - Giving medicine
    - Cleaning up
    - Transport of goods
- Relational tasks: Tasks which are done in interaction between the service giver (here: the nurse) and the service receiver (here: the patient or the resident), e.g.:
    - Basic care
    - Curative care
    - Emergency care
    - Transport of patients
    - Ward round
    - Direct communication to patients and residents
- Heteronomous tasks: Tasks which prepare the service receiver (here: the patient or the resident) for an active collaboration, e.g.:
    - Information for patients and residents

Additionally, there were categories for other tasks which do not fit in the available categories, and for nonworking time.

Directly after the three days in the clinic and the retirement home, the project partners had short workshops with the nurses they had accompanied in the clinic and the retirement home. The aim of these workshops was to exchange the experiences from the nurses and researchers made in these three days. The researchers reported what they had noticed about the processes (what seems to work well, where could the nurses need support), and the nurses commented on it. Although these workshops were quite unstructured and without preparation (as they were conducted in-

stantaneous after the three days), first opportunities for the use of an automated guided medical trolley turned out.

In the weeks after this visit and first workshops, the researchers developed a first rough process model for typical service processes in the clinic and in the retirement home, based on the information from the visit. The processes are defined with the “three component model”, which will be explained in chapter 2.3., and visualised with “yEd Graph Editor”.

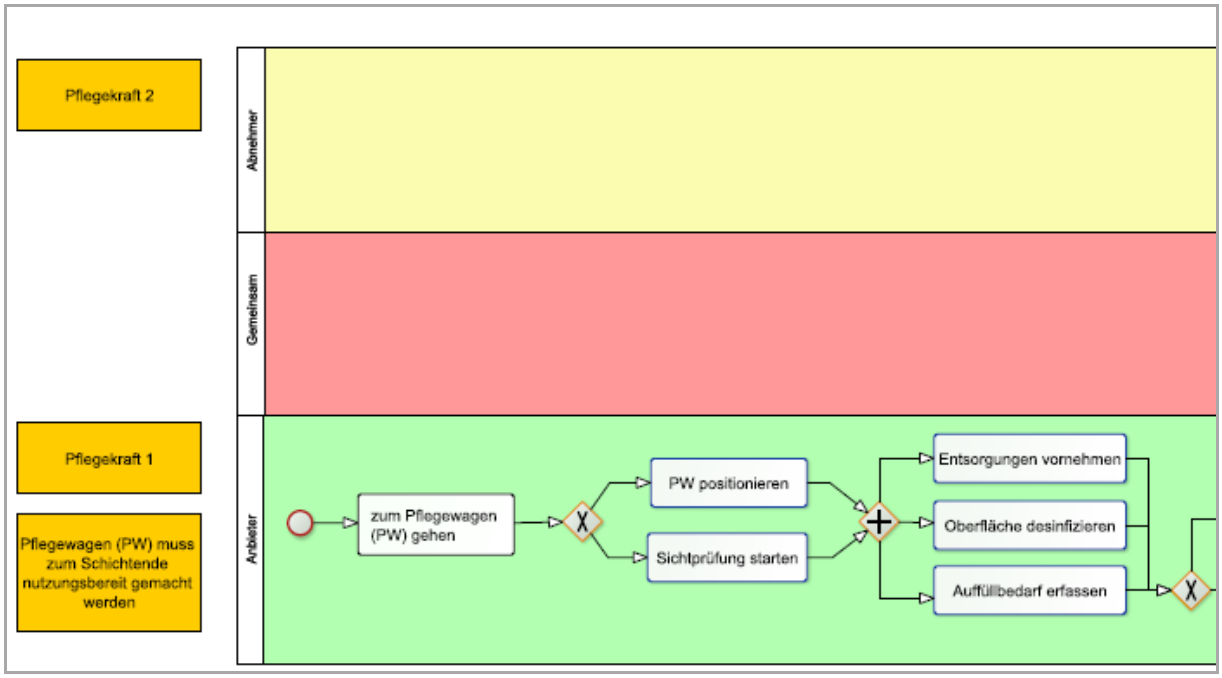


**Figure 1: Extract from process model**

For the clinic, two processes were visualised. Both of them are about the use of the medical trolley. The first process is how the nurses check the content of the trolley at the end of their shift, refill it and prepare it for the next shift. The other process is about the use of the medical trolley when they care for the patients during their shift. The process which was visualised for the retirement home was about how the trolleys with the laundry are used in case that a resident has to be changed and the bed has to be made up with fresh sheets.

Fort he clinic, it was soon clear, that the medical trolley will be automated and that the process from filling, using and refilling the trolley will be focused. In the retirement home, the decision was more difficult, as there exist many different trolleys which could be automated, e.g. for clean laundry, for dirty laundry, for dishes, for waste.

The researchers prepared additional workshops, one with experts from the clinic, and one with experts from the retirement home. For these workshops, they further developed the focused process for the clinic and suggested three processes for the retirement home. The processes for the retirement home were the following: The use and refilling of the trolley with the clean laundry, the use of the trolley for the dirty laundry and the disposal, the use of a new trolley which contains a basic accoutrement with laundry and offers enough space for the medicine which is needed in a ward round.

In the first workshop, the researchers and the experts from the clinic discussed the idea and the requirements of the clinic for an automated trolley. In the second workshop, the researchers and the experts from the retirement home discussed which trolley from the three ideas is the most useful if it is automated. The experts favoured the third idea with an automated trolley which the nursing staff can take with them when they care for the residents and distribute the medicine.

## 2.2. Development of survey instruments

After the processes were defined in which automated trolleys shall be tested, the technical partners started with the development and construction of the trolleys under consideration of the requirements from the clinic and retirement home.

The other research partners started the development of the survey instruments. The aim of the surveys is to record the service processes before and after the use of automated trolleys in order to be able to redesign service processes later on. As it is likely that the use of automated trolleys changes the daily work of the nursing staff, changes in the service processes concerning quality and productivity are possible.

In a first step, survey instruments for the analysis of the current situation without automated trolleys are developed. The surveys shall be conducted between October and December 2015, as the test of the automated trolleys will in January 2016.

For the following process steps in the clinic, survey instruments are needed:

- (1) The allocation of care materials at the ward
- (2) Filling the medical trolley with material at the beginning of the shift
- (3) Using the trolley
- (4) Checking the stock of materials and order

At the current stage of the project, the survey instruments are being planned and developed by the research partners and will then be discussed with the participating clinic and retirement home in a workshop. For this reason, at this point of time, the paper can only give a rough idea about the planned survey instruments.

For the first process step “the allocation of care materials at the ward”, it will be observed several times how the care material which is delivered once a week through the automated goods transport system is put away and ranged in the different stores at the ward. It should be found out how much different material is currently stored, how big the packaging units are and which material is ranged in which of the stores and why. These questions are crucial in order to find out how the filling of the medical trolley could be improved in the future, e.g. by ordering smaller packages which fit better in the trolley or by a modified storing which reduces the ways between different stores.

For the second process step “filling the medical trolley with material at the beginning of the shift”, there will also be observations. At the end of the shifts the trolley is refilled with the material which has been used and expended. These situations will be observed several times and it will be recorded which materials must be refilled and

from which store it is taken. Additionally, in a workshop with a couple of nurses or in individual interviews the nurses will be asked about typical problems and incidents at the refilling process and about ideas for improvement.

For the third process step “using the trolley”, a couple of methods is planned. First of all, the use of the medical trolley is observed. For this purpose, the trolley and/or the nurse is fit with electronic devices which record for example the length of distances, the time needed, the distance between nurse and trolley or the pulse. Additionally, a structured questionnaire is to be filled in by the nurses about the stress and strain at the workplace and about the acceptance of automated systems in the health care system. Then another questionnaire is filled in by the head nurse about the organisation of the ward (cf. Hasselhorn, Müller, 2005). The aim is to analyse and evaluate the organisation of the ward in order to find out how the organisation could change through the use of automated trolleys and how this would be accepted.

For the last and forth process step “checking the stock of materials and order”, documents about the orders of material from the last twelve months will be analysed in order to find out which material is needed in which amount over a period of time. This could give hints how the storage could be reduced and which material is currently not stored in the trolley although it is constantly needed. Additionally, the person in charge for the orders (normally the head nurse) is interviewed about the characteristics, routines and possible changes in checking and ordering materials.

From all these analyses and data, process models will be developed for the four different processes. These models will be created with the three component model, which is explained in 2.3. The process models are discussed in a workshop with responsible persons from the clinic (e.g. head nurse, health care leader) to check if the processes are correctly represented and to change them where necessary. In a second part of the workshop, the processes are discussed with regard to possible improvements regarding quality and productivity, especially, but not only, through the use of automated medical trolleys.

For the processes in the retirement home, similar survey instruments should be applied, although the process steps differ somewhat. In the retirement home, the trolley which will be automated in future is currently used only for the transport of laundry. It is planned to automate it and to make it to a trolley which contains additionally basic care materials and, if possible, medicine. Thus the current processes which are object of the analyses are the following:

- (1) Taking the laundry from the basement to the storage in the residential area
- (2) Filling the trolley with the laundry
- (3) Using the trolley
- (4) Taking the used laundry into the basement where it is collected and brought to the washhouse

Like in the clinic, the instruments will be observations, interviews and workshops. At the current stage of the project, the detailed planning about the instruments is not as advanced as for the clinic.

These surveys aim at the representation of the current processes without automated trolleys. The surveys will be conducted between October and December 2015. At the

beginning of 2016, the automated trolleys, which are being developed, will be experimentally implemented in the clinic and in the retirement home for a couple of weeks. While and after this experimental use, the next survey unit will be conducted in order to record the future processes. The survey instruments will be developed in the further course of the project.

## 2.3. The three component model

The three component model is a process modelling method which subdivides different process parts into three components.

In the service process, the provider and the customer refer to each other. They mutually control their constructive action. For service providers, it is characteristic that they need to integrate the customer. They are reliant on the cooperation of the customers. To be able to offer the service, it is for example necessary that the customer is present at a specific place to a specific time, or that he gives certain information (cf. Bornewasser et al.; 2014).

Every service process consists of sub-steps, which are corporately generated by provider and customer. Some sub-steps are generated by the provider, some by the customer and some by both together. Consequently, three different components of the service work can be distinguished: activities, which conduct the provider, activities, which conduct the provider together with the customer and activities, for which the provider gives instructions to the customer (cf. Bornewasser et al., 2015).

The first mentioned activities are the **autonomous** component of the model. The second mentioned activities are the **relational** component. And the last activities are the **heteronomous** component.

The provider is in an autonomous position, and the customer temporarily resigns his right of proposal because he expects to satisfy his needs in this way. There are never two autonomous partners in a service situation. It is always one autonomous partner who gives specifications and, relational to this partner, a heteronomous partner, who is integrated into the service. He can participate, he can disturb or he can quit the system. Concerning these decisions he is quite autonomously, but as soon as he engages in the service, he is heteronomous governed by the other partner (cf. Bornewasser et al., 2015).

This approach leads to a structured representation or model of service processes. The model contains three stripes. In the green stripe, all the process steps which the provider conducts autonomously, are recorded, in the red stripe, all the collective made steps, which are coordinated by the provider, are recorded, and in the yellow stripe the heteronomous process steps, which are conducted by the customer, are recorded (see figure 2).

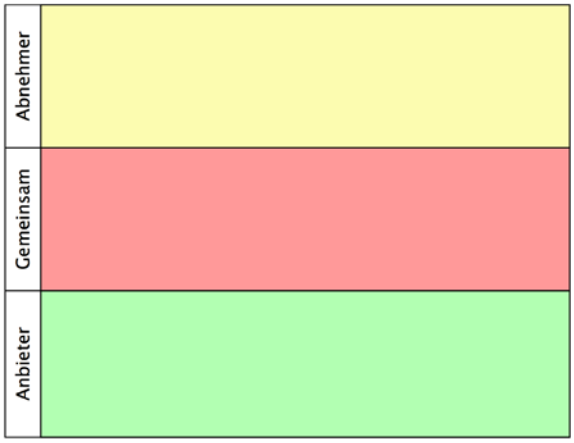


**Figure 2: Empty pattern for three component model (cf. Bornewasser et al., 2015)**

In this model, all process steps should be registered in chronological order and categorized in the three stripes.

The aim is now to improve service processes, which means to increase the productivity without downgrading quality. Originally, productivity means the proportion between output and input (cf. Ganz et al., 2013). The productivity could be increased in different ways: the same result could be achieved in less time or with fewer resources or with less process steps (cf. Bornewasser et al., 2015). But a process oriented productivity definition focuses on the analysis of the service process with all its steps and the question, if the current arrangement should be kept or changed, in other words, if the process should be reorganised. For the three component model, it is also important to decide how the process steps should be distributed in the different components (stripes) (cf. Bornewasser et al., 2015).

For those service steps which are conducted only by the provider and which the customer does not notice, many productivity rules from the industry can be adopted. But if the provider acts together with a customer or if the provider delegates process steps to the customer, the customer needs, customer wishes and the customer contact must be considered. This means that in services the relational parts should be as little as possible, as far as it does not impair the customer wishes. The steps in the relational component (the red stripe) should be changed and made to heteronomous steps (which requires good and precise instructions from the provider to the customer) or to autonomous steps.

In summary, productivity of services results from three aspects (cf. Bornewasser et al., 2015):

- Service providers improve or automate components which they can design on their own.
- Service providers explain the customers how the service process works and navigate the customer through the process.
- Service providers design all the cooperative and interactive service steps in a professional way and replace the direct parts with indirect parts (for example information via electronic devices or guide signs instead of personal communication).

The three component model will be used for the visualisation of the processes in the clinic and in the retirement home. With the rules for productivity and quality in mind, suggestions for further improvements of the processes and a reasonable implementation of the automated trolleys are made.

# 3. Summary and conclusion

The experience in the project so far showed that it is important to get a first impression of the processes in the facilities in question before starting with concrete and structured surveys and that the technical possibilities and the needs of the facilities have to be balanced permanently.

This is why the research partners first of all visited the clinic and the retirement home impartial and then identified together with the experts from the facilities the processes which should be further analysed and in which an automated trolley could be integrated. The functions which shall have the automated trolley are developed in the field of the technical possibilities and the requirements of the facilities.

With the three component model, a suitable method is found to visualise the current processes and to find point where the process could be improved by automated trolleys or just by the change of service steps.

# 4. Acknowledgements

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