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Mobile Application Systems for Home Care: Requirements Analysis & Usage Potentials

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ABSTRACT

Home care services increasingly gain importance due to demographic implications: insights on recent developments in Germany hereby relevant to industrialized countries like the USA are given. Portable application systems have only been established sporadically in German care environments unlike the comparable domain of technical field service. This paper will identify possible mobile usage scenarios by matching healthcare requirements to state-of-the-art concepts, such as product-service systems. Open potentials concerning the support of actual care processes can be concluded thereby. An integrated mobile application system can minimize knowledge deficits and enhance the quality of home care. The results are of potential relevance not only to patients and caregivers but also to different providers of healthcare or IT solutions.

Keywords

Home care, mobile application system, product-service system, nursing processes.

INTRODUCTION

Problem

The domain of home care is one of the biggest future challenges for Western industrialized nations and their public health, especially due to the increasing number of chronically ill and multimorbid elderly persons to be medicated in their societies. Forecasts by the U.S. Census Bureau state that the share of seniors above 65 – with the vast majority concerned by multimorbidity – will grow from 12.5% to 20% of the total population by 2030 (Souare and Lloyd, 2008). Therefore, similar implications can be assumed as currently investigated in Germany that will then face 3 million inhabitants estimated to be in need of nursing – an increase of nearly 150% compared to today's level (Statistisches Bundesamt, 2009). Since care generally shifts from inpatient to outpatient environments, a global shortage of qualified nurses becomes even more prevailing (Anderson, Jay, Anderson and Hunt, 2005; Hannah, Ball and Edwards, 2006; Simons, Egami and Perry, 2007). Moreover, the willingness for family care diminishes leading to additional demand for community nursing in Germany (Statistisches Bundesamt, 2007).

Home care comprises periodic home visits by a nurse (or other healthcare providers) for monitoring and treating patients with post-operative or chronic conditions as well as their support regarding household activities (Gesundheitsberichterstattung des Bundes, 2011; Simons et al., 2007). Working in this field especially requires high temporal flexibility and consists mostly of tasks 'on the go'. Due to its mobile character with activities carried out at varying locations, this type of assignment can be distinguished from inpatient care in hospitals or retirement homes. Even communicating work-related with colleagues or picking up items at pharmacies occur underway (Rügge, 2008). Altogether, the factors 'time' and 'mobility' represent increasingly critical resources in home care. Brettlecker, Cáceres, Fernández, Fröhlich, Kinnunen, Ossowski, Schuldt and Vasirani (2008) claim Information Technology (IT) can affect them positively along with the cost situation.

Amongst aforementioned industrialized countries, the USA, Canada, Australia, New Zealand, the U.K. and other countries of the European Union, such as Germany supposedly suffer from a lack of efficiency and quality in healthcare that they attempt to resolve using IT (Anderson 2007) especially in ambulatory scenarios (Jha, Doolan, Grandt, Scott and Batese, 2008). Whereas IT represents an inherent part of inpatient environments today, more support in home care is still demanded (Brettlecker et al., 2008). Parallel progress has extended conventional IT-approaches to portable devices so that they can be used where care professionals work in mobile scenarios (Kafeza, Chiu, Cheung and Kafeza, 2004).

The article at hand examines whether IT-prerequisites could enable home care professionals, especially nurses, to cope better with the aforementioned structural changes. Possible starting points to improve the situation will be discussed subsequently.

Purpose & Motivation

Some authors examined community nursing parallel to the scenarios of after-sales technical field services (TFS) (Rügge, 2008). As a mobile service, both have in common that they are carried out at changing locations (Andriessen and Vartiainen, 2006): hereby, the primary assignment is performed in reality although requiring work to be fulfilled in virtual IT applications, e.g. administrative tasks. Furthermore, actual service providers remain usually left to their own resources. In this context, especially the trend of equipping service staff with portable IT-applications is remarkable (Rügge, 2008). Deriving a contemporary IT-utilization from the latter domain seems worthwhile because of aforementioned analogies and since the main tasks in the field of home care are similar to those in TFS:

- Firstly, the complex process of assistance as such (in this case, patient care),

- And secondly, the documentation of this process, comprising the service provided, as well as the status found (here patient's health).

Due to IT-applications' lack of physical presence, mainly the second aspect has been regarded as being appropriate for support. Furthermore, it must be ensured that it is possible to access the assisting systems underway. To assess the motivation for IT in new healthcare domains, a concrete analysis must be conducted beforehand - thus detecting domain specifics and detailed potential benefits for all stakeholders. Addressing those potentials facilitates the acceptance by potential users (Hannah, Ball, Edwards, Callahan Hunt, Breckenridge Sproat and Rutherford Kitzmiller, 2006).

The following sections offer an overview of mobile technologies used in TFS and healthcare. It should help identifying potentials of mobile applications for home care, considering the industry-specific requirements and distinguishing them from previous concepts. Prior to that, it is necessary to define the methodology.

RESEARCH METHODOLOGY

Up to now, the scope of research in this aspect of home care appears to be relatively limited. Therefore, based on grounded theory (Glaser and Strauss, 1965) we use qualitative methods for generation of preliminary requirements: these results may be refined and validated in consecutive quantitative studies and combinations with those (Kaplan and Maxwell, 2005) by discovering e.g. more exact criteria or research areas.

To understand the home care situation in more detail, preliminary research was initiated concerning this and related domains of application. It is accomplished by reviewing scientific literature of the last decade concerning IT in particular service domains and expert interviews as sources. This methodology follows the approach of Jha et al. (2008) having been tailored to flexible IT-solutions in healthcare, focusing on two objectives:

- On the one hand, we intended to prove the current use of IT and thereby identify (implicit) needs for possibly missing solutions as well as potential influencing factors from shortcomings discovered.

- On the other hand, first requirements for possibly demanded solutions should be induced from practical experience.

For this initial research phase, qualitative expert interviews were conducted. Targeted were persons in charge of IT at German home care providers. The "guided interview" was the selected format for questioning: this is an instrument of empiricism based on guidelines for gaining information with open questions. The guideline can be used as a flexible checklist that doesn't stipulate a compelling order of questions. This enables the interviewed person to deal with the topic and may lead to new aspects and topics not yet considered by the interviewer (Patton, 1990). In our approach, the procedure's flexibility helped identify IT-solutions in use. The gathered findings will be presented in Table 1.

From a design science research perspective according to Hevner, March, Park and Ram (2004) we first establish adequate, solution requirements for the actual application domain in the paper at hand. Evaluating their problem solving ability or performing iterations required will follow mostly in subsequent work since this approach is in progress.

LITERATURE REVIEW ON STATE OF THE ART

General Use of IT in Healthcare

Healthcare has adopted IT in many scenarios. This also applies to the usage of portable devices (Kosteva, Schaller, Brian and Strayer, 2005). There have emerged various application areas frequently using mobile solutions, e.g. for documentation in hospitals. Most of the offers being referred to as "mobile" represent PC-applications ported to PDAs or tablet PCs (Rügge, 2008). However, wireless devices will be negligible until they are made more convenient regarding size and input options (Tachakra, Wang, Istepanian and Song, 2003).

The majority of nurses uses IT also for professional reasons and can therefore be considered affine in this area (Gilmour, Scott and Huntington, 2008; Morris-Docker, Tod, Harrison, Wolstenholme and Black, 2004). Also, caregivers utilize handhelds (Brian, Brian, Hildebrandt and Stolworthy, 2005). Despite this obvious competence, IT resources provided by hospitals often lack (Hübner and Sellemann, 2005). If equal preferences are assumed for home health systems, circumstances for mobile IT usage aren't better due to the varying workplaces. So, systems to support outpatient care were developed (Anderson and Aydin, 2005) but for physicians' practices (Aydin and Forsythe, 2005) or desktop applications like scheduling, GPS-fleet management respectively resource planning, e.g. in German home care providers' settings (Lipinski, 2005). Others target quality assurance (Hannah, Ball, Edwards, Sensmeier, Newbold and Cato, 2006). So generally, they have been used for billing, administration and documentation on stationary devices (like the solutions presented below in Interview Results section).

Home Care Approaches to mobile IT

Although research on IT in nursing has focused on hospitals (Aydin, Anderson, Rosen, Felitti and Weng, 2005), a few approaches exist, here. Handling paper-based documentation could become redundant: care-relevant data can already be recorded directly using portable devices and transferred through interfaces to existing information systems conducting the planning and further processing. Possible errors during data entry and resulting inconsistencies are avoided and documentation generally facilitated because manual transfer of data is no longer necessary. Quality and operation management are thus supported and administrative work simplified (Lipinski, 2005).

Also, scattered smartphone-based systems particularly address following tasks:

- Recording nursing services at point of care and data transfer into the central information systems as a basis for billing the insurance company and salary accounting.

- Planning assignments, appointments and routes with recording of time spent at site of caregiving and dependent modifications.

- Central procurement platform for mobile ordering of medication with an implemented prescription supply chain (physician-to-drugstore).

Such solutions were developed and practically tested in cooperation with care institutions. However, continuous difficulties concern especially user-friendliness, linking different stakeholders or missing compatibility (Rügge, 2008). Helpful insights might be gained from other domains' solutions.

Use of mobile IT in TFS

In recent approaches, mobile application systems are used by German TFS in industries such as wind power, automobiles, mechanical or plant engineering. There, notebooks or PDAs are already part of the service providers' equipment (Bernhard, König, Krupp, Pflaum and Strauß, 2010; Thomas, Krumeich and Fellmann, 2010) and online via mobile communication networks. Manufacturers provide the field technicians with additional information concerning their service, for instance the workflow of machine-specific maintenance or repair processes. Those are thereby endowed to generate customer benefits through the combination of machine, service, documentation, process consultation and modern IT. That provides process-oriented information with a justifiable effort. Through the integrated composition of such a hybrid solution, service provision can be designed more efficiently. In this environment similar to the domain of home care, for instance a combination of process modeling, mobile applications and others had been proven to be an innovation driver (Thomas et al., 2007).

EMPIRICAL RESULTS

Interview Outcomes concerning IT in Home Care

The questions for the expert interviews have been ordered in four sections (see Table 1) as they occur in home nursing (Rügge, 2008) to allow for a more specific retrospective interpretation. Aspects affecting the planning, preparation and maintenance of rosters should be taken into consideration for *shift scheduling*. In this case, IT-solutions would primarily be used by the management of the nursing team to create the duty rosters for care. After these have been prepared, precise *day's scheduling* have to be drawn up and controlled in a second step. Based on these two processes, the actual *nursing* can be carried out. Potentially relevant information in this step is the patient's anamnesis, treatment and medication. Finally, information on the care provided has to be *documented* for the home health system and other stakeholders like patients, health insurance companies or physicians.

All of the six experts interviewed act as heads of nursing responsible for IT at their home care provider. Partly, they are even active caregivers.

Home Care Requirements concluded

The methodology described above and applied to the interviews led to findings (see Table 1) that can be used – in combination with the outcomes of the literature research – to derive core results and requirements (see Table 2). In the following chapter we will explain how these results can be integrated as a basis into future research.

RESEARCH AGENDA

Systematization of Fields examined

Several application fields emerged during pre-study especially in literature review. Those can be structured according to the particular purpose that IT is supposed to support. A classification completing the interview categories would be:

- Service planning/ scheduling

- Communication with customers, colleagues, partner company or other stakeholders interested in the service provision

- Actual process of service provision

- Documentation of service provision

- Logistic execution of the service, also with external partners

- Billing and other administrative tasks for service provision

As a result of this, areas can be clearly identified both where sufficient solutions have been developed and where not available yet.

	Questions	Answers
Shift scheduling	Who does prepare the rosters?	Nursing service's management (4); IT-department; teamleaders
	How is the roster prepared?	With "Microsoft Excel" (4); with systems "Pflegedienst 2000"/ "MediFox"
	How can the roster be accessed? (multiple answers allowed)	E-mail (4); Bulletin (4); verbal communication; via Internet
	How flexible is the roster?	Very flexible (2); less flexible (2); not flexible at all
	Is the solution selected for the roster satisfactory?	Yes (5); No
Day's scheduling	Who prepares the day's scheduling using which solution?	Scheduled by nursing service's management with "Microsoft Excel" (3); Scheduled by nursing service's management using IT-systems "Pflegedienst 2000" or "MediFox"; Scheduled by nursing service's management, visualized on a magnet board
	Is there an optimized route planning (where appropriate) for day's scheduling?	No, nurses know the routes (4); little tolerance due to target schedules; No navigation device, but "GoogleMaps"; defaults from "Pflegedienst 2000"
	Who does coordinate the day's scheduling?	Nurses (3); nursing service's management (2)
Nursing care	Where can the patient record be viewed before the treatment?	Discussion/ presentation of each patient in the team; Central record in the head office and "Pflegedienst 2000"; (Electronic) Patient record; "MediFox"-anamnesis; Patient documentation; briefings
	How is the medical history accessed?	Patient record at site (3); hardcopy in care folder; via "MediFox"
	Where does the information in the medical history originate from? (multiple answers allowed)	General practitioner, physicians (6); Family members (4); nurses (3); person in charge (2)
	Who maintains the medical history?	Nurse (3); nursing service's management (2); quality assurance team
	Is the information given by the medical history sufficient?	Yes (6)
	Which additional technical tools are used during care?	Cell phone (6); MDA; Laptops often not preferred by nurses
	How does the communication take place between nurse and patient when not on-site?	Telephone routing via the care provider's office (3); Directly via the nurse's cell phone (3)
	Who does record the need for medicine and how/ where is it recorded? (multiple answers allowed)	General practitioner (4); Drug regime (3); Results from care documentation or from assigned prescription
	Who does order medicine?	Nurses (2); employees in the office of the nursing service
	Where and how is medicine ordered?	According to patients' wish (2); from drugstores by fax (2); from the physician or online
	Is the medicine taken documented?	No (4); Yes, in care documentation (2)
Documentation	What is documented?	Services provided (5); Patient's state of health; medical values (blood pressure, etc.)
	Who does the information target?	The care service itself (2); health insurance company; (family) physician
	What is the documentation aimed at?	Billing with health insurance company (2); performance record; course of disease
	How is the billing data documented?	Handwritten only (4); handwritten, digitized later

Table 1. Research Questions & Answers (in parentheses if nominated >1)

Result	Requirement derived
Stationary applications are used during the planning/ scheduling processes. Up to now, existing mobile IT-applications, e.g. for documentation, are practically rarely used by nurses – handwritten work prevails, coordination is carried out verbally or via notes in records.	R1: Solutions should be targeted at the nurses who are still rarely recognized as users.
Larger mobile hardware-solutions, such as laptops or tablet PCs are often not available nor preferred by nurses. However, cell or smartphones are already common, therefore have potential.	R2: Portable devices should be small to achieve user acceptance.
Overall, heterogeneous IT-environments mostly prevail at home health systems including media breaks and only a few integrated solutions.	R3: Integrative concepts may constitute an additional benefit.
Home care service providers do not wish to make IT their core competence, staff responsible for IT is designated rarely.	R4: IT-solutions should be available from external providers.

Table 2. Results from Pre-Research and derived Requirements

Potentials derived for Home Care

Most of the topics discussed in the previous chapter have been examined concerning the application domain of home care providers, as documented in the chapter on literature research: Approaches for IT-solutions to support scheduling, documentation, billing, logistics or administration exist for portable use. Until now, IT was claimed neither to be able to directly support actual caregiving (see R1) nor have potentials in this context been pursued any further (Reichert, Peleg and Lenz, 2008).

So far, due to the lack of technologies available, nursing support has been carried out mostly using written notes on papers or the staff's memory and has been characterized by long distances and/ or heavy equipment (Rügge, 2008). This becomes also evident when viewing the existing printed descriptions of nursing processes. In a German guideline book for home care of several hundred pages, more than 130 different multi-step activities are listed, e.g. concerning the complex treatment of fractures or giving medicine: Supported by illustrations, information is provided regarding indication, symptoms, preparation, execution, postprocessing or necessary auxiliary means like medicine or bandages (Döbele, Becker and Glück, 2006). Nearly the same content and size apply to US definitive books (e.g. Hegner, Acello and Caldwell, 2008). Additionally, approaches exist for quality assurance with the help of process steps, but with potentials for more IT-support (Berg and Toussaint, 2003).

Home care needs to focus on patients, the required quality of processes as well as efficiency and costs (Kosteva et al., 2005). However, deficits may arise at any time during nursing, for instance due to the lack of knowledge regarding certain procedures (Giehoff, Hübner and Stausberg, 2009). This is an interesting aspect, given the fact – as stated initially – that there is a lack of qualified staff. Since laptops are too heavy (Kosteva et al., 2005), smaller portable IT-systems (see R2) may bridge the information gap and avoid errors during care in this respect. Consequently, both quality and cost position is improved. Applying this concept to home care is also supported by the assumption that mobile IT-systems can be used as portable specialist reference books in healthcare (Leimeister, Krcmar, Kuhn and Horsch, 2005). Because the potentials concerning both quality (Lauterbach, 2009) and time-saving (Albrecht, Wolf-Ostermann and Friesacher, 2010) through IT-based documentation are doubted in Germany, another way of IT-support may add crucial benefit: It must be possible to retrieve illustrations and instructions at the place of service provision. This is an integral part of the service and also applies to home nursing (Rügge, 2008). Still, process-oriented systems transparently representing care tasks lack (Pryss, Tiedeken, Kreher and Reichert, 2011; Reichert et al., 2008). Additionally, if the requirements listed in the corresponding section are taken as a basis and compared with the related field of TFS, it becomes obvious that relevant up-to-date information (see R3, R4) can be provided on portable devices. In this way, a service providers working autonomously is assisted in generating customer value-added by an auxiliary knowledge base (Thomas et al., 2007). It could become obsolete for the nurses to carry printed guidelines for caregiving processes because those can be visualized and updated through graphical process models on the mobile devices used by default. A concrete application is presented subsequently.

SOLUTION DESIGN

Sample Process Representation

The potentials of process-oriented application systems, similar to those in TFS, are presented here on two levels: first, we show how real caregiving processes can be represented and subsequently, how such solutions can be implemented. Before creating an IT-based presentation of standardized quality assured nursing processes on mobile devices, those must be modeled. As an example, the workflow for changing a dressing is illustrated domain-specifically with the Business Process Modeling Notation (BPMN), as one alternative recommended by Heß and Meis (2011) (cp. Figure 1) and could also be displayed similarly on small-screen-devices (cp. Figure 2).
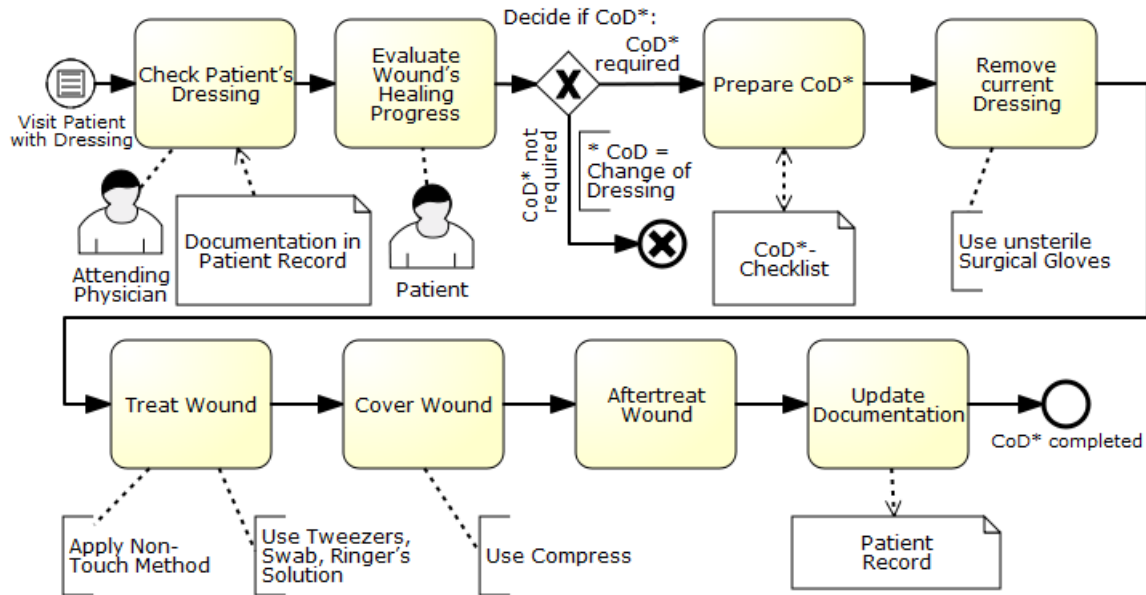
Figure 1. 'Change of Dressing' Process, exemplified in BPMN (construed from Döbele et al., 2006)
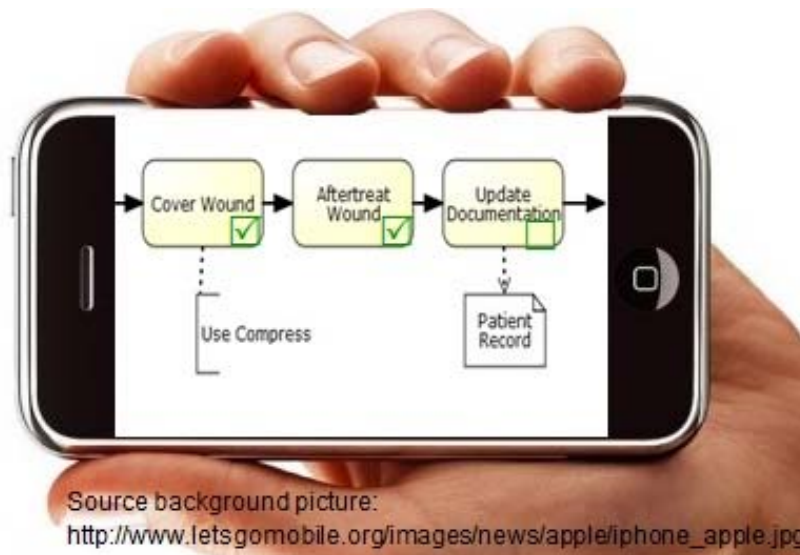
Figure 2. Sample Nursing Process' Activities displayed on Smartphone

Implementation Scenario

Possible scenarios for implementation should be designed following a holistic approach: embedded into existing hardware such as smartphones, integrated into respectively linked to other software systems via interfaces. An approach can be transferred from TFS: product-service systems (PSS). This concept describes the merging of production factors, the physical product and service-relevant information into efficient service processes. The service of a provider can be organized in a more customer-oriented and efficient manner through the use of such hybrid bundles of products and services, e.g. by using documentation and state-of-the-art IT (Thomas, Walter, Loos, Schlicker and Nüttgens, 2007).

The innovative aspect of this approach represents a PSS developed through the combination of nursing service, documentation, process consultation and modern IT-products, as illustrated in Figure 3 including the stakeholders involved. That suggests feedback cycles and can be extended. Home health systems can e.g. receive additional services (besides software and hardware) from solution providers, like central data management, software updates or quality assured, standardized respectively customer-tailored nursing process representations. Another example could be linking documentation to avoid media breaks and generate synergies, for instance through automated filling of checklists during caregiving (for further complements see *state-of-the-art* section).

Such an approach might help the collaborating partners with focusing and applying their core competencies best possibly (Bititci, Martinez, Albores and Parung, 2004). This results in innovation as experienced in TFS enhanced through the feedback from the recipient of care to the caregiver concerning quality, as well as to the various solution providers concerning requirements (Thomas et al., 2007). Quality improvements as to expect by standardization of care (Simons et al., 2007) could be achieved for patients but also for public authorities and organizations such as health insurance companies and public health systems. Because of the costs reduced thereby, these and additional stakeholders (see Jimison, 2005) might as well be attracted by holistic PSS: e.g. physicians or suppliers of pharmaceuticals or dressing material.
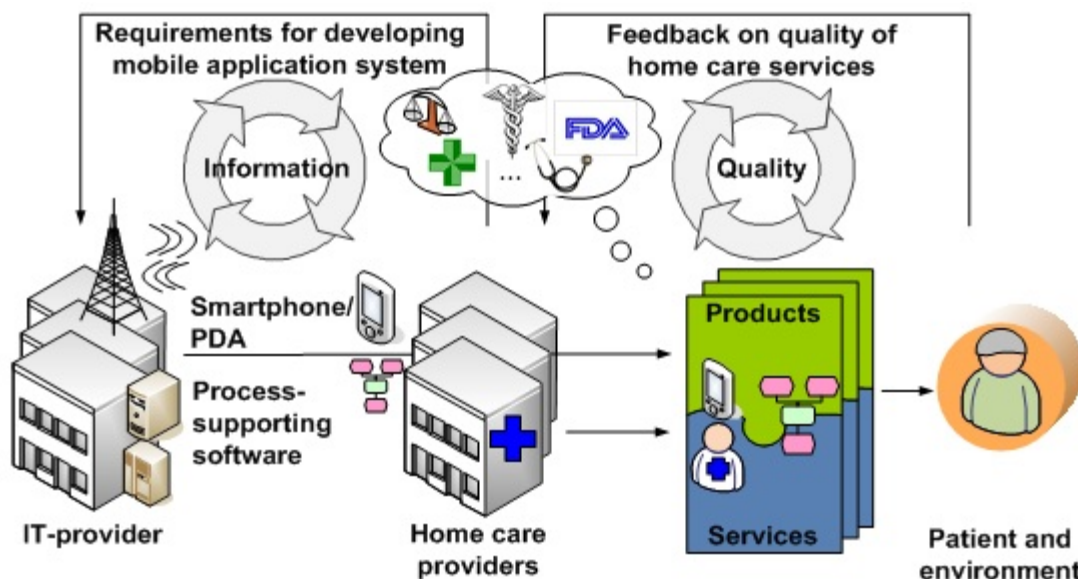

Figure 3. Hybrid Value Chain of our PSS in Home Care

NEXT STEPS & CONCLUSION

Especially home care increasingly faces structural deficits to be reduced by using PSS-integrated IT. The hardware platform should be a well-established, small mobile device like a PDA. In combination with healthcare services these application systems lead to hybrid solutions for home care very likely to generate additional benefit for stakeholders when integrated into holistic concepts for nursing support.

How to implement this must be scrutinized by a comprehensive approach as initiated here. For further evaluation, a more comprehensive study with a larger survey must be carried out to validate and collect interest and requirements for PSS and IT-support for care processes: Nurses, as recommended by Harrison and Lee, 2006, must be questioned as well. This would lead to more detailed results than achieved during pre-research. To do so, the existing questions must be elaborated and widened for an extended target group. For international significance, also stakeholders in additional countries with comparable situations should be approached. Concrete feedback possibilities for the ideas in this paper concerning the representation of care processes or business models in terms of PSS must be integrated. Since home care providers do not focus on IT according to our pre-study, it must also be identified whether or to what extent they are willing to delegate such application systems to external providers. As for all IT matters in healthcare, problematic aspects like of legal kind must be considered (Brettlecker et al., 2008), additionally: e.g. the relevance of FDA's or German Act on Medical Devices' regulations (Federal Institute for Drugs & Medical Devices, 2009) to mobile application software in an integrated solution approach.

Preliminary results – also obtained through analogy to another domain – indicate potentials for novel mobile application systems. Those should be utilized more frequently, e.g. regarding concrete care activities' quality assurance via additional information in process models. In this respect, it must also be examined and identified how an intuitively comprehensible, visual form of presentation, as well as text or optional voice output could be devised. This would be beneficial for optimized user-friendliness and for improved quality for the patient. Initial conversations with trained nurses, experienced staff of care providers and researchers in that field have evaluated our concept positively.

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