Redesigning work with a Light Weight Approach to Coordination Technology

Authors:

Marit R Halvorsen, M.Sc., R.N.[1], Hanne O Austad, M.Sc.[2], Andreas D Landmark, M.Sc.[3], Dag Ausen M.Sc.[2], Ingrid Svagård M.Sc.[2], Tanja Tomasevic M.D., MPH[1], Trond Trondsen M.Sc.[1]

1 Oslo Accident and Emergency Out-Patient Clinic

2 SINTEF Digital

3 SINTEF Technology and society

Corresponding Author: Andreas D. Landmark, SINTEF Technology and society, SP Andersensv. 5, 7030 Trondheim. Andreas.Landmark@sintef.no, +47 73 59 30 00

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Abstract

Coordination of information and resources are central to efficient ward management. Tools to aid such coordination include standardised procedures and paper lists, and more recently electronic tools such as whiteboards and mobile solutions. This study report on the experiences and effects of designing and implementing collaboration technology and how the use of light-weight technology has enabled redesign of traditional work processes. The process followed the principles for user-centred development and is evaluated through observations and informal interviews of users and stakeholders.

In addition to the expected changes in work processes, we found that short redesign cycles with heavy user involvement afforded by this technology, enabled implementation of new ways of structuring and combining information that were not foreseen. This turned the collaboration technology into a tool that also guided the prioritizing between tasks and contributed to the effects seen in use of resources, user satisfaction and quality of treatment.

Keywords: Hospital information systems; Coordination; Collaboration Technology; Light Weight Technology; User-centred

Introduction

All types of medical services require communication, information sharing and coordination of work between health care professionals. The coordination of work in ward care is in itself a significant part of nursing work. Hendrich et al. describes how approximately 21% of nursing time across 36 medical surgical units was devoted to care coordination activities[1], an equivalent time to that spent on patient care activities (19%). There are many different forms of coordination and collaboration systems for medical work, all of which aims to improve coordination and collaboration in hospitals. Coordination may be message passing and telephones, to felt-marker whiteboards or various electronic counterparts in the form of mobile apps and specialist coordination software (scheduling/planning software).

Proper planning might seem like a viable option to reduce the explicit coordination activities, and other studies[2] have shown why technological support for continuous planning is necessary to support and sustain healthcare work. The coordination and handling of variations and breakdowns in planning also requires different amounts of information, creating a requirement for both "information sparse and information rich"-systems[3]. Transitioning to electronic whiteboards as a platform only increases the functionality of whiteboards as coordination tools. The work by Bardram et al.[4,5] shows how "shared interactive displays" supports namely social, temporal and spatial awareness. Studies of electronic whiteboards has shown that users of electronic whiteboards indicates that it "improves and standardizes communication within the care team"; and that it "saves time when searching for information on a patient and their care plan"[6]. Studies of information sharing and messaging between cooperating organisations in healthcare have shown that the effects are varied from satisfied users, but no reduction in phone usage[7], while others found that the factors for successful information sharing via messaging ranges from social and organisational issues[8] to the mix of policy, organizational and patient-related issues constrained their ability to fully exploit the benefits of e-messaging[9,10].

The challenges of designing patient care information systems and the necessity of viewing system engineering and organizational development as an entwined process is well described[11-13] and that collaborative work coordination systems, such as electronic whiteboard solutions, usually exist in an ecosystem of pre-existing legacy and other expert systems that contain information pertinent to the coordination activity. The role of collaboration software is often to act as the information mediator, aggregating and display information from their surroundings. As such, providing a stop-gap measure to the information fragmentation between various expert systems; in itself not an insignificant challenge to patient safety (causing avoidable adverse events and medical errors), the cause of inefficiencies (misplaced or delayed access to information leading to duplicated tests and procedures, and increased length of stay), and in turn increased health costs[14].

A central point[11], is that implementing (new) technology in an established work practice is as much a organisational-political process as a technical one, and requires a thorough socio-technical grounded and bottom-up well-designed process. Thus an iterative, user-centred approach, can help reduce the distinction between systems analysis, design, implementation and evaluation, which Berg[11] argues ultimately is closer correlated to "success" (in some form) than by meticulously following guidelines or "critical success factors". In a similar vein, Monteiro critically assesses the assumptions underlying the drive for integration as a key to [healthcare] information systems success, in combination with the streamlining of activities in a business process perspectives, encourages (the partial unintentional consequence of) seeking tighter integration of systems[15]. The "single all-encompassing EPR" design have given way to distinct classes of expert systems for different roles (EPR, PACS/RIS, Laboratory Information Systems) and even integrated systems may contain impediments to collaboration[16].

Distinction can be made between "[this] well-established knowledge regime of large systems" and the more recent growth in more loosely coupled systems with smaller scope and more distinct purposes[17]. This latter trend is named Lightweight Information Technology (LWT). This is similar and a related development to *consumerisation* and *bring-your-own-device* schemes, were deployment is

done by users or vendors directly, and change is often more rapid and agile than when traditionally controlled by a central IT authority. Apart from the more organisational and deployment issues, Bygstad claims such a light-weight approach to system development and deployment has profound effects on the ability to do innovation work in the organisation[17]. Bygstad describes the distinction between "Heavy-" and "Light-" weight technology as[17] "Heavyweight IT is here defined as a knowledge regime, driven by IT professionals, enabled by systematic specification and proven digital technology, and realized through software engineering. Heavyweight IT is becoming increasingly complex and specialized, while light- weight IT emerges as a new innovation arena, allowing non-specialist to experiment with cheap technology".

Our working hypothesis was that actively embracing and using LWT as a phenomenon enables an agile and potentially innovative process for technology introduction, namely seeking the effect of the innovation arena described by Bygstad. The effect of the technology would improve the information flow, and in turn enable changes in the work processes, unthinkable without technology. Altogether this would allow for an eventual better use of resources and increased user satisfaction and quality of treatment. In this study, we report on the observed effect of introducing and using LWT paradigm for information system development in a short-term hospital ward. We report on effects of improved internal and external information flow, but particular emphasis is put on effects of the electronic collaboration tool (with whiteboards and mobile solutions) advancing from a platform sharing single information pieces to a platform aggregating structured information into overall variables more useful for planning, coordination and interaction across professions, wards and organizations.

The research case has been the focus of previous studies[18], reporting on the process of implementation of certain changes. In this study, we conduct a summative assessment at the end of a three-year process.

Case and research design

Research Case

The service that was studied consists of three wards with 24 beds each. The nurses are assigned to specific wards, while there is a common physician service that covers all three wards. The service runs 24 hours / 7 days a week; patient discharges are primarily within office hours. The service in this study is based in Oslo, Norway and serves a population of 650,000 people. It had 5,385 admissions in 2016 (adjusted for increase in capacity, similar to 2015 numbers)[19].

The wards studied adopted a commercially available IT solution. The main component used is a reconfigurable collaborative tool, which combines logistics with resource and patient management. The solution is primarily to support logistics within and between wards by sharing real-time information. Additionally, a mobile client solution allows the same information to be shown on mobile devices. The sum of these components constitutes a loosely coupled distributed system. The shared information space is an *addition* to the electronic patient record and is neither judicial nor de facto a record keeping system. There is a separate EPR that serves that purpose. The information space is designed to be a collaboration platform for ward work.

The shared information space consists of an information grid, typically used with patients in rows and information in columns. The system responsible at the ward (in our case typically a nurse), can define the contents of the columns. Reconfiguration of the information space is relatively simple and is handled by the system responsible nurse, without assistance from an IT department to reconfigure the information. Configurable filters allow showing different information in different settings, ensuring that the most relevant information is available for a given situation. Information from several columns may be combined in a result column, e.g. based on logical rules.

Throughout the article we refer to the shared information space, independent of whether it is accessed by a mobile client, on an electronic whiteboard or a desktop computer.

The motivating challenge

The baseline study performed in year one of the study revealed several areas of improvement and the need for both organizational changes and technological solutions were identified. Neither the organization nor the technology support enabled effective use of time, resulting in several bottlenecks in the ward and several risks to the quality of the treatment was identified. This was visualized in a "mountain of challenges", showing how the lack of organisation of certain tasks through a normal day caused significant bottlenecks for the wards, accumulating into a “mountain” of unfinished tasks at the end of the day-shift. The time schedule for the day was not coordinated well enough within the ward and not taking into account external input and interruptions. External phones mainly come in from about 11AM, followed by admittance of patients from around noon. Tasks that are not finished in the relatively calm morning hours would take significant more time when the doctors and nurses are constantly disturbed – with several documented examples of breakdowns in communication and coordination between doctors and nurses. The technology in use at the time was primarily telephones, whiteboards, and paper lists (all used as is common in hospital wards). In the sections below, we will cover the main changes implemented and the effects of the changes. Several other smaller changes have been implemented as well and they all add up to the overall effect.

Research Method

The study has been conducted in an innovation process that follows the principles for user-centred development, as outlined in ISO 9241-210: Human-centred design for interactive systems[20]. The innovation process has gone through different phases as illustrated in Figure 1. This is per recommendations for Norwegian Municipalities and is in line with the principles described by the standard.

[Figure 1 here]

The project that was studied has aimed at user driven innovation process and from 2014 department management and employees went through several interdisciplinary workshops to identify and agree

upon workflow and core tasks from admission to discharge through the project phases. Several iterations with shaping of ideas, implementation and evaluation has been carried out, where organizational changes and technology changes have been carried out iteratively. Different solutions have been tested out in different parts of the organization before successful solutions have been implemented in the entire organization.

The participation of researchers has been a trans-disciplinary action research approach; as a joint activity between researchers and practitioners contributing "both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework"[21]. The researchers are both participants as well as observers in the development of organisation and technology. This affords the researchers detailed insight into processes, procedures and data, whilst at the same time maintaining scientific rigor and relevance[22]. The scientific as well as practical knowledge were discussed and developed with the stakeholders themselves in discussing core findings as well as committing themselves to further design, pilot and test new solutions[23].

The design of the data collection followed a protocol were 3 researchers performed field observations yearly. These observations were conducted over three days per instance where the observers participated in the internal life of the unit job shadowing a designated healthcare professional on each shift. Consideration was given to cover a mix of both weekdays and morning and evening shifts. The observers were all full-time researchers with 5+ years' experience in field observations within healthcare, with background either in healthcare or healthcare IT. The observations were documented in free-text field reports that were shared with the practice field for feedback (for corrections and confirmation). These were also shared with the project as input in the innovation process. As part of the workplace evaluation, electronic surveys were distributed to all employees via e-mail, yearly (timed to the innovation/evaluation cycles in the project). This included questions on cooperation/collaboration, rounds, report/shift handover, tools and usability and a final

section on perceived technical stability and operations. The survey included questions that were designed based on insight from the baseline observations at the beginning of the project.

The data collected has been used as a formative assessment, as an integrated part of the innovation project and the development of both system and organisational processes. In this article, we present a more summative assessment at the end of a three-year process, drawing upon the data collected along the way.

The Regional Committee for Medical Research Ethics approved the study and it has been reported to the Norwegian Social Science Data Services (NSD).

Results

The initial steps were to construct a 24-hour patient day plan. This lead to more focus amongst the clinicians on the scheduling and completion for key daily tasks. The technology has been used to structure the day e.g. through whiteboard meetings. In the baseline observation, we found that the nurses often simply did not know when the physicians' morning round would start. Sometimes the physicians' morning round did not finish during the nurses' day shift but continued in the afternoon. At the end evaluation this was significantly improved, with set times that was met in the majority of days.

[Figure 2 here]

The intention of the whiteboards was for them to be *interactive* shared information spaces. However, it became quite clear that meaningful interaction with the software was as much on regular desktop PCs as the wall-mounted whiteboards. The introduction of the mobile client and the uptake in physician use, led nurses to bring the tablet- or smartphone version of the tool out on rounds, assigning tasks, tests and procedures in real-time when the physician gives orders on pre-round and/or round (see Figure 2).

The effect of mobile clients was two-fold. First, it caused a significant and observable difference in the behaviour and use of paper lists as a personal coordination tool. The paper lists still exist, but not as such an important carrier of information between rounds, and given the use of mobile solution at the point of care, also less as a memory-aid for later information entry. On the observation round at the end of Year 3, all the nurses observed used a form for mobile device for access while on rounds. Secondly, the amount of information, and the contemporaneity of the information available in the collaboration tool increased. From becoming an after-the-fact documentation solution, the tool had become something closer to a proactive planning solution. This was supported by the employee survey among the nurses and doctors that reiterate the findings from the observations study.

In the survey, 85% of the nurses (40/47 nurses) were positive (agree-strongly agree) to the statement "It is easy and simple for me to gain an overview of activities for my patients after rounds", and similarly 85% agreed, "After being assigned patients, it is easy to find updated information on my patients". 50% of the nurses reported to use the LWT as the primary source for updated information starting a new shift, 30% used the paper list with extracted information from the LWT. 20% uses the EPR as their first source for information.

Structured information

Through the innovation process, three structured information elements have been implemented in the collaboration tool. This structuring of information and codifying key-shared patient information became crucial for the uptake of the solution. Explicit examples of structuring of nursing information includes; Fall Assessment: This was implemented based on National standards[24]. Fall risk was assessed for six categories of factors (e.g. mobility and cognition), (in addition any prior history of fall) and results presented as Yes (red) or No (green). Activities of Daily Living (ADL): A slightly modified version of the index[25] The score (1-40) indicates what the patient are able to manage him-/herself of daily activities. National Early Warning Score[26], an aggregation of six physiological parameters, all routinely measured. The individual scores are based on how extreme the parameter

varies from the norm. The total is increased for people requiring medical treatment with oxygen, intravenous, or other emergency care.

The scores were made interactive to foster uptake and additional rewards, for instance the summary of the NEWS-score could be broken down into the individual constituents of the score (respiratory rate, saturation, etc). By request from the physicians, to bolster use, the display was modified to include a small red dot on a yellow score to indicate that there is at least one red parameter hidden behind the aggregate. Having the information displayed in real time as an overview for all patients at the ward increase the benefit of the scores, compared to having the scores in the EPR. The benefit of the open display of the values ensures that everyone, not only the patient responsible nurse, notices divergent values. Ward management also use the structured information in the tool to get an overview on the ward to assess the workload and allocating resources and new patients.

This is very much in line with Wong et al.[6], wherein the communication between physicians and nurses, which earlier was slightly hampered by difference in interests, now focuses on a smaller set of standardised (between disciplines) indexes. The interpretation of the indexes and implications for each disciplines work, still differs. It does however, allow both disciplines to accumulate and coordinate[27] for the best of both disciplines.

Physicians prioritization of patients

The structured information (ADL, NEWS and Fall) together with diagnosis, biochemical test results and planned date for discharge is used to set the physicians priority for the physician's daily patient visit, the priority is clearly shown and used for filtering between the prioritisations of patients.

[Figure 3 here]

The ability to accumulate information quickly, to prioritise between patients with very differing needs (and different goals for their stay) and the development of a general accepted prioritisation scheme was critical to keep the time schedule for the ward. To keep the time schedule and avoid the "mountain of challenges" observed in the baseline study, is necessary to ensure quality of the care to

all patients. The technology offered an arena of making such a prioritisation explicit [27]. This was as much a process of organisational change rather than technological, but the development and effected change was definitely a socio-technical interplay between the two.

In the observation, we found that the structured information and quantified priority became the focal point of the morning and afternoon reports in the physician team. These meetings are conducted as a common handover of patients between physicians working the night and day shifts, and similarly in the afternoon between day and afternoon. A less formal round is conducted between afternoon and the overnight shift. Without an explicit *and shared* prioritisation, the discussion on the priorities did not happen, as the understanding of the patient corpus was not shared between the physicians (see Figure 3).

The whiteboard became the common access method to the shared information space used in the meeting and acted as an up-to-date agenda and the common source of information for the leader of the meeting. The structured information and explicit prioritization were the guiding principle for which patients were discussed in the joint meeting. More in-depth consultations were taken “offline” between the physicians directly responsible on outgoing and incoming shift.

Information sharing with others

The system has also seen expanse into information sharing with new actors not initially considered at design-time, as shown in Table 1. These were unplanned or unintended consequences of LWT acting as a *platform* for other information services – including roles and professions in the organisation not considered at the design of the system. These are all examples of information sharing with actors indirectly involved in patient work, but critical for the coordination of patient care and optimal use of the resources. The information shared was already contained in the solution and made accessible as filtered information views adapted to the access and information need of each role.

[Table 1 here]

Additionally, Information sharing external to the organisation, was piloted with 2 out of 15 city districts (receiving discharged patients). The baseline observation showed that the ward nurses used a significant amount of time checking for electronic messages with these actors in the care chain (primary city districts' home-care/assisted living), answering additional questions and making calls to clarify. In cooperation with the city districts, a message structure using the ADL-standard[25] were adopted and two city districts were given real-time information about their patient through the LWT platform. The end evaluation shows that compared to baseline, there were in general less focus on the communication with city districts "as a problem", and an apprehension among the nurses that it was less time consuming. In the employee survey, 69% reports that the communication with the city districts is "good most of the time or always".

The *process* of defining the LWT interface with the city districts, and the evaluation of ADL for all patients, is likely to have increased the consciousness of what information the city district need, so that the electronic messages have become more precise and contain useful information to all city districts. Thus, the ADL score process itself has helped in the communication. However, the observation and informal talks with nurses indicate that the real-time sharing of information with the LWT with the two city districts has so far not shown any improvement in the number of messages or time used on the discharge process.

Organization of nursing activities

The wards were originally organised around group nursing, where a group of patients is assigned to a group of nurses. The nurses share the responsibility but the nurse in charge of the group is responsible for the contact and coordination with other groups and the physicians. Patients reported that they had to deal with many nurses and experienced little continuity. The organization experienced that the interaction around the patient was fragmented, which contributed to increased stay time because the city districts did not receive satisfactory updated information on time and hence could not plan adequately for care transition/care take-over.

Based on the experience with coordinating through the shared information space, the wards switched assigning a specific 'primary nurse' to each patient (per shift, but preferably sustained across shifts). This new organization increases the number of nurses (approximately three-fold) that a physician has to coordinate with. It was commonly acknowledged during the observations, by both nurses and physicians, that this organizational change was made possible by dedicated technology solutions in the form of electronic whiteboards. This provided the necessary support for coordination information. In the mid-survey, 80 % of the nurses reported that the change, "somehow or greatly" had contributed to increase efficiency and quality in the patient work, the majority of the rest did not know. 60 % of the physicians reported the same, while the rest there were equally divided between small contributions and "did not know".

Discussion

In this study, we wanted to investigate the effect of introduction of a collaboration tool using a light-weight technology-paradigm (LWT). In our study, the access has been through desktop computers, wall-mounted whiteboards and mobile clients in the form of tablets and phones. Our working hypothesis was that the technology could provide an improved information flow that in turn could enable changes to working processes (that would be impossible without up-to-date information at the point of care). The consequences would include better use of resources and increased user satisfaction and indirectly bolster the quality of treatment. We found that the technology improved the information flow through availability for healthcare professionals at the point of care, and that some of the organisational changes introduced would be difficult or impossible without sufficient information flow.

To capture benefit from new technology and changed information flows, changes to organization and work process is required. In this study, changing and adopting internal and simple information to external partners proved easier and gave almost immediate effect. However, the attempts at more complex information exchange, where the benefits rely on partly organisational change, not surprisingly proved much more difficult. Unsurprisingly, perhaps, but closely related to the discussion

of *fit or congruence*[13], and the term *benefit* itself can be discussed both with regards to the timing of evaluation and the speed of change.

However, an important "success factor" for balancing this through the process was namely "Light-weight technology" as a paradigm for system engineering. This was highly beneficial with respects to enabling real change and maintaining agility in end-user involvement. As for the innovation arena, as described by Bygstad[17], this effect was central to the results in this research case, akin to a "success factor" in itself. The ability for the clinicians themselves to assume responsibility and hence also the ability to change and develop their own information spaces – takes user-involvement beyond contributions in development workshops and into their day-to-day work.

Information flow

Our hypothesis was that collaboration tools would improve information flow (over baseline paper-based procedures), but after the baseline observation it was concluded that organizational changes was needed to be able to aggregate and utilize the information in the platform. Berg describes how information technology in healthcare primarily serves two purposes[27]; accumulate and aggregate data-elements into meaningful wholes, and secondly allows coordination of complex processes of interaction and collaboration. We have in this study seen several examples of how the successful introduction of technology into the organisation is more about the ties between technology and organisation than its constituent parts[28].

One of the organizational changes identified through the study was the change from a group-nursing system to a primary-nurse system, and we have seen how the LWT provided the required coordination support to enable this transition. However, as an organisational change directly, this would have been more difficult without technology support that could grow along side the maturity in the organisation for such a change. The shared information space provided a stopgap measure that reduced the cost of coordination sufficiently for this to be possible. On the other hand, this was also dependent on the physicians using the tool to balance admission of patients, as well as the more

direct public display of activities and progress which made the shared information space assume some of the role of the group function – and emphasises the collective responsibility.

Both nurses, physicians and management highlighted the physician patient prioritization process using the tool as a very important result for efficiency without compromising quality. The physician is a limited resource on the wards, and this functionality makes it easy to compare the patient and use the time correctly. The prioritizing makes it possible to keep the tight schedule of the day plan the majority of days.

The external information sharing for these wards is based on the same messaging platform as used throughout Norway[29]. Studies have shown that one message more often is the initiator of a series of messages and phone calls – i.e. a dialogue. This is confirmed in our observations, too. This form of communication limits the benefits of the system we have studied in that the sought benefit of electronic messages is primarily on the technical/systems side[10] (safe, electronic and not paper based), whilst the work- and quality process benefits are minor. Sharing parts of the structured information between organisations was an attempt to reduce frustration in repeated communication and in part structure the dialogue and is in line with recommendations. We believe that the structuring and creation of shared information spaces supported and fostered a discussion and reflection on work practices – and thereby contributed to the rethinking and improvement of the practices that the tools aimed to support.

The experience however, is that moving towards a more joint understanding of health service requirements and patient condition, even with standards such as ADL, is challenging and probably requires a longer and extended process to build a common understanding across different organisations. Using the LWT to share loosely defined information in a dialogue requires the same development of acceptance to standardization of information (e.g. ADL or similar). The benefits of loosely coupling (i.e. light weight) is also lost across organisations where the dialogue-partner adheres to other traditions and systems. In a network of organisations, with different practices and

little physical interaction, this understanding is harder to develop than internally within a ward. In contrast, one-way communication of *defined* information presented much less coordination to achieve common understanding (e.g. kitchen, switchboard and cleaners), and as such much easier to implement the needed organizational changes necessary to exploit LWT.

Use of resources and Quality of care

It was expected that LWT would facilitate the process of improving information definition, aided by the use of national standards. It was clear that the use of national standards and protocols increased the quality of the health and care services in several areas. The use of means that all the patients are assessed according to the same criteria and procedures. Earlier, the individual nurses carried out the patient assessments at his/her own competence and discretion. The idea was that this would also ease the communication to the various receiving care facilities. However, the creation of shared understanding across the organisational boundary was more difficult than the internal effort, regardless of the standard employed. Use of fall risk assessment in the interaction increase the patient safety culture at KAD, this was more easily communicated to the home-based care in the city districts.

The implementation of use of national standards are not dependent on LWT, but the light weight design makes it simpler to adapt and implements changing protocols and standards directly in the tool for assessment and documentation at low cost. It also lowers the bar for trying out ways of structuring information. Also, the open display supports a common responsibility for all patients and it is added value to see the assessment for all the patient together, not one by one as in the electronic patient record.

Success factors and Innovation with LWT

The iterative method with interaction between technology innovation and organizational innovations, as well as the user-driven innovation process, has been essential. Some of the most valuable results, as the physician quantified prioritizing, would not have been possible to plan or foreseen in the initial phase of the project.

The LWT enables clinical personnel to implement changes without support from IT department or vendor and is loosely coupled to other systems, enabling cost-efficient development of end user solutions. This short time required and low cost associated with translating new ideas to actual IT-implementation, have fostered the innovative process. Gaps in system support traditionally often leads clinicians to design their own tools to facilitate the access to coordinative information outside and between existing systems[30,31]. However, electronic tools are often more complex to design, develop and deploy. LWT has provides some ability where shortcomings in existing systems can be addressed by reconfigurations to the collaborative tool – and improvements to the tool can also be effectuated by the staff themselves.

The employees have been involved from the planning of the project, and have given valuable input in all the iterations. However, this should not be understood as purely bottom-up development. In this study, we have seen transition from loose ideas to concrete terms, but making them implementable has often been driven through by project management. A structured and competent project leader is required to carry seeds and loose ideas from workshops through one or two solution development iterations before the final solution sufficiently addresses the requirements of the original idea. In the socio-technical interplay between technology and organization, the user-driven innovation of processes and tools requires an analytical and empirical sensibility [32], addressing practical and immediate concerns. This analytical ability seems to need support from professionals experienced with iterative development processes, working within the constraints and possibilities of the technology being used. Additionally, the support from the top management with room for trial and error in developing new ideas has been essential to bring along the successful changes.

Limitations

This study has been conducted in close collaboration, and with a duality between being a researcher and a practitioner. Part of the research group has also had roles in the organisation, and the researchers have been embedded and participated in the department over an extended period of time. This have had an impact on how we frame our results, as well as by being there, we have

influenced the development of the work practices and the LWT solution. In an action research practice, this is not so much an adverse consequence as a sought-after effect of integrating researchers and practitioners in an action research social contract.

Conclusion

The introduction of collaboration technology has improved the internal and external information sharing and enhanced the patient safety culture. The LWT is found to support in a good way the basic tasks on the ward – e.g. follow up, blood sampling, observations, food, rehabilitation. The establishment of an arena for sharing information in real-time also opened a discussion of coordination and prioritisation across disciplines.

We trace the successful implementation path to go through the use of a light-weight approach to information technology, both in development and implementation. As a more traditional turn-key solution, the process would neither have reached the same end-state nor enabled the organisational development throughout the process.

LWT enables a middle-way where the clinicians can modify and reconfigure their own tools. This opens up for possibilities not evident from the start. The use of several iterations and a trial and error approach were information content in the LWT were changed and revised for each iteration, leads to effects that was not prioritized and foreseen from the start.

Similarly, some of the heavier organisational processes, such as shared priorities and division of labour and responsibility would have been difficult to impossible to develop and implement without a shared space wherein they could be displayed, discussed and changed.

This study has shown that LWT is a tool that may support and help drive organisation change. The looser coupling between systems, but more importantly also more flexible connection to work processes and organisational structures, means that the benefits of such a technology adoption is

larger than the individual tools themselves. This we believe is generalizable outside the scope of a short-term ward and applies to work-supporting technology in general.

Further work

Formal evaluation of technology introduction requires a more holistic approach to benefits than described in this study. However, we have collected metrics of more economical nature and directly patient-care related measurements that could describe and provide a control for adverse effects from the technology and changes in workflow.

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Legends:

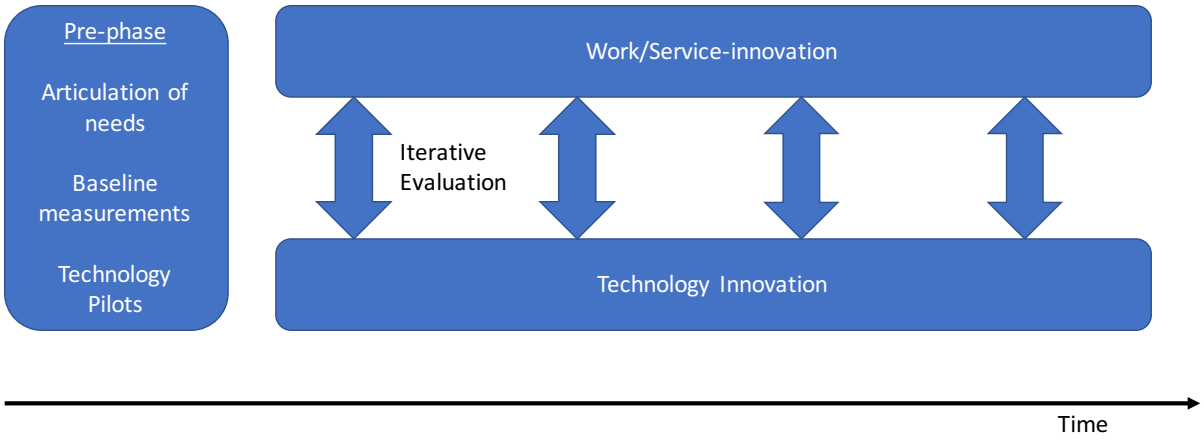

Figure 1 Research Case: Overall project design following ISO 9241-210

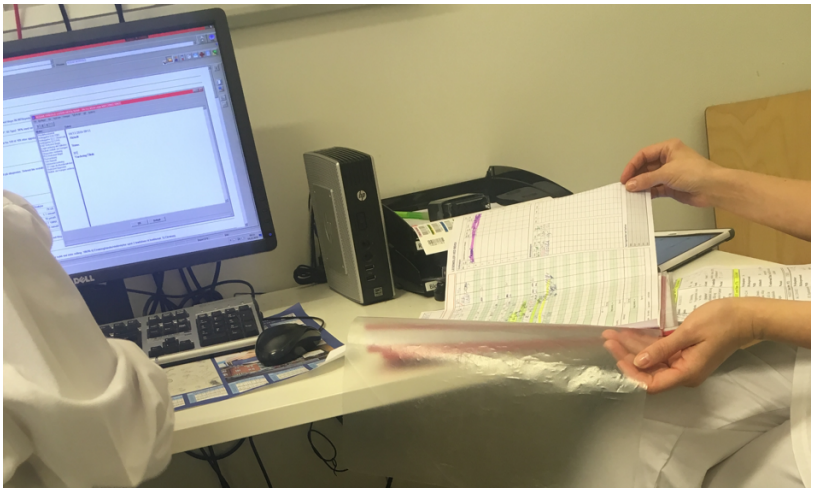

Figure 2 Pre-rounds meeting between the physician (left) and the nurse (right). Nurse reviewing paper chart, with tablet solution just visible underneath the curve. Physician reviewing EPJ on desktop computer.

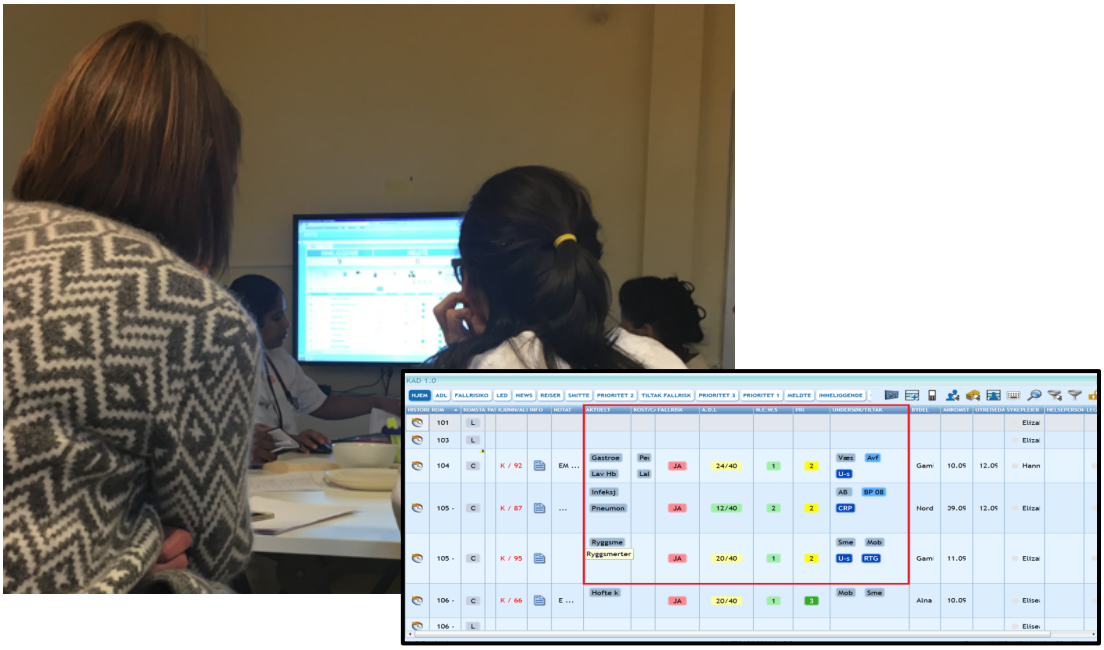

Figure 3 Picture showing Physician's morning meeting, joint screen in the middle of the picture (Inset is a screenshot from the joint screen).

Table 1 Examples of Information Sharing with other actors

Actor	What	Effect
Kitchens	Established a shared information space with the external kitchen and replaced a paper-based food supply scheme with stock-keeping and one common order for the external kitchen.	Patients now receive food at the same time (better preparatory work). Fewer stock outs. Patients are given a choice in menu.
Cleaning	Established a shared information space with the cleaning staff (on pre-existing iPads). The information shared includes rooms on leave, pertinent information for cleaning (infection control, etc.). Allows cleaning to better plan the order of rooms, and reports prepared rooms back to the common information space.	Fewer breakdowns in coordination causing rooms (unnecessary) unavailable for new patients.
Switchboard	Established a shared information space between wards and main reception that indicate where patients are, as well as the destination of incoming/leaving patients; important for coordination of transport.	Fewer phone calls to locate patients or destination of transport services. Frees up a lot of time for the nurse on duty at each ward. Stopped circulation of printed patient list twice a day for record keeping.