How Future Patient Safety and Future Work Environment is Considered During Design and Procurement of Work Space for Advanced Medical Technology Equipment.

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HTO framework (humans, technology and organization) (Eklund, 2003) proposed an extended framework for interactions between human, technology, organization and environment, with work activities shaping organizations’ processes. It was intended to guide analysis of work activities, work systems and organizations in areas as safety, health, well-being and systems’ performance with goals of improvement. Procurement routines are found in management systems, (operations). Monitoring by medical equipment can be divided into work activities, which can be facilitated by technology, organization, environment and context. At the procurement stage, part of the design of future operations is determined. Procurement (and planning) is also affected by business practices and regulations, affecting future work environment. The HTO-models structure, with extensions to environment and context, makes it a suitable model for analysing the procurement process. The study Procurement within high-tech risk sites - nuclear power identified important steps in the process for inspection and self-regulation in procurement (including design and projecting) of high security rated zones in nuclear power (Jakobsson, Svenson & Salo, 2010). The identified steps will in the current study be used as a tool, combined with HTO-model. In current study HTO-model combined with the step model will be used as analytical tool for planning, designing and procurement (named procurement) in security-intensive care with focus on future patient safety and work environment. Patient Safety. Healthcare professionals working situations and incidents were investigated after one patient's death during post-caring observation after a heart surgery in an intensive care unit (Swedish Accident Investigation Authority, 2013). The report pointed out that mistakes occurred that happened in earlier patient care in connection with monitoring. Mental stress due to unclear procedures and high workload caused lack of patient safety. The inquiry also showed that the premises design was poorly positioned. These factors reduced the staff's ability to work patient safely. Swedish National Board of Health and Welfare has also conducted briefings in patient safety (Alven, Lööf & Soop, 2014). Work Environment. Architects drawings are of great importance when planning before construction of working premises. They must take into account ergonomics and workplace aspects, so that healthcare staff can work safe. Design of work environment has implications for organizational and mental circumstances at workplaces ((The Work Environment Act, 1977), §2).
Work Environment Act first chapter, states, "Technology, work organization and job content shall be designed so that employee is not subjected to physical or mental stress that can lead to illness and accidents". The combination of physical environment, placement of technical equipment, teamwork and treatment of patients are potential stressors. It can give effects such as reduced cognition, performance and discomfort. Work conditions are regulated in different provisions.

**Practitioner Summary:** The practice innovation is to; by the HTO-model (Eklund, 2003) and the identified important steps (Jakobsson, Svenson & Salo, 2010) examine the planning, design and procurement process concerning premises for advanced medical equipment and is expected to provide suggestions for improvement in future patient safety, work environment, and systems performance. Approximately ten interviewees who are part of a project team for planning, design and procurement will be examined by semi-structured interviews. A questionnaire will be distributed to about 30 employees affected by a contract. Written instructions will be thematized against the theoretical models. All answers from interviews and questionnaires are written down and integrated in the models. Expected Findings. The framework HTO (Eklund, 2003) together with the identified important steps (Jakobsson, Svenson & Salo, 2010) can be utilized and adapted for the description of the procurement process of workspace for advanced medical equipment (including design and projecting) and that the HTO framework combined with the step model as analysis tool of the procurement process will lead to suggestions for improvement in future patient safety, work environment and system's performance, thereby among others provide a basis for health care in their work to develop the procurement process relating to safety and health.

**Keywords:** Patient Safety, Work Environment, Procurement model, HTO-model, Design

1. **Theoretical background and purpose**

In section 1.1 through 1.6 we will present two theoretical models (1.1 & 1.2) that we will use in the study. Also we will present some concerns and regulations concerning patient safety (1.3) and work environment for the staff (1.4). Last in the section we will present how we want to combine the two models (1.5) and our aim for the study (1.6).
1.1 **HTO (Humans, Technology and Organization).**

Eklund (2003) suggested a wider framework for interaction between Humans, Technology and Organisation and further Environment (Figure 1). The framework emphasized work activities as formers of organization processes. The framework intended to function for analysis of work activities, systems of work and organizations in areas such as security, health, welfare and system performance with possibility of improvements.

![Expanded framework for interaction between Human, Technology and Organisation and further Environment, HTO (Eklund, 2003).](image)

Figure 1. Expanded framework for interaction between Human, Technology and Organisation and further Environment, HTO (Eklund, 2003).
1.2 Procurement in tech risk activities - nuclear power.

Jakobsson, Svenson and Salo (2010) identified important steps in procurement process for inspection and self-monitoring at procurement in high safety classified zones in nuclear power (Figure 2). A stepwise model was created (Figure 2). The stepwise model from the procurement nuclear study (Figure 2) will in the current study be combined with the HTO-model (Figure 2) to investigate the procedure for procurement in a healthcare environment.

Figure 2. Flow diagram of the procurement process.

(1) Initial Assessment of Needs
(2) Feasability Studies and Decision about Project
(3) Start the Design
(4) Analysis of Project Needs
(5) Project Team Created
(6) Specification
(7) Time Schedule
(8) Market Analysis/Preliminary Suppliers
(9) Procurement requirements and criterias and competitive bidding process
(10) Delivery Specification
(11) Tender Evaluation
(12) Negotiation
(13) Final Choice of Supplier
(14) Follow Up-Production and Delivery
(15) Experience Feedback
1.3 Patient safety.

The work situation and incident reporting for medical staff was examined after a death had occurred during aftercare and monitoring in an intensive care. The investigation found that mistakes had been previously reported in the department that had to do with monitoring. Mental stress caused by unclear procedures caused lack of patient safety.

The investigation also showed that the department's space where monitoring by medical equipment occurred had a substandard design and drafting. These factors reduced the professional capacities of working patient safely. The report shows recommendations concerning the management system at various levels, training on medical equipment, instructions regarding equipment connected to patient safety and usability reviews of instructions at the handing over of equipment from manufacturers to users also with patient safety management, premises linked to patient safety and medical devices and monitoring alarms and information transfer without extraneous interference (Swedish Accident Investigation Board, 2013). National Board has completed two reports in patient safety (Soop, Alvén, Lööf, Ljung, 2013; Alvén, Loof, Soop, 2014).

1.4 Work Environment.

The Government Bill 1976/77: 149, concerning among others laws of work environment, describes psychosocial factors as an elusive phenomenon with the working environment as a whole observed from an psychological and sociological perspective, with both physical, organizational and social factors effecting the work environment rather than individual.

The design of the workplace has consequences for the organizational and social circumstances on the workplace. Architectural drawings are very important in planning before the physical design of workplaces. Designers and architects must therefore take into account the ergonomic and practical aspects of work so that medical staff can work safely.

Design of the working environment has an impact on organizational and psychological factors at work (Working Environment Act SFS 1977: 1160, §2). Environment Act (SFS 1977: 1160) also states that it is not enough that the work is as risk free as possible in physical and mental sense but that there also should be objectives about commitment and job satisfaction and that there should be a concern of people's different conditions.

AFS 1980: 14, psychological and social aspects of the working environment, section 2 expresses inter alia concerning the physical environment that furnishing and formation of equipment effects to inter alia the possibilities of communication. Noise is mentioned as one of the significant physical work problems with effects such as reduced performance, discomfort and stress reactions.

The Report from the Accident Commission (2013) summarized that the work environment for employees of intensive care should be examined with a focus on the availability of appropriate conditions for the operations in the form of suitable premises, procedures, equipment and sound levels for management and receipt of alarms from medical equipment. This was pointed out since improper environments adversely affect the daily work and that the work environment becomes negative for the staff also at serious incidents and accidents.

1.5 HTO framework (Eklund, 2003) as a tool for analysis of design and procurement in safety demanding medical care with focus in future patient safety and future work environment combined with the step model for procurement (Jakobsson, Svenson & Salo, 2010) of safety critical environments.

A routine of Procurement and design is found in operations management, (operations) (Figure 1). Monitoring with help of medical technology equipment may be broken into work activities, which may be facilitated or hampered, by technique, organization, environment and context. Already at the design and procurement stage, parts of the work activities are determined.

Procurement and design is among other things affected by routines and applications, which is thereby affecting the future work environment for staff and safety for patients. The context (Figure 1) is also an
important factor for procurement of security demanding activities. Therefore the HTO model structure with the additions of environment and context seems a suitable model for analysis of design and procurement process in combination with the step model to procure security-intensive, high-tech equipment and/or services (Jakobsson, Svenson & Salo, 2010).

1.6 Aim of Study

The aim of the study is to find improvement proposals of the design and procurement process in areas such as patient safety, personnel health and welfare and system performance by examination of the procurement process for intensive care by advanced medical technology equipment using step model for procurement (Jakobsson, Svenson & Salo, 2010) combined with HTO model (Eklund (2003) as an analysis tool.

(1) Examining routines and applications for design and procurement process in procurement of work areas of intensive care with advanced medical equipment.

(2) Which are the requirements and routines to integrate Patient Safety and Work Environment in the design and procurement process where advanced medical equipment is procured?

The analysis will aim to develop the procurement process especially with focus on patient safety and work environment in the health care.

2. Method

The data collection and analysis is in the current state not carried out but we will be able to present some results at the conference/congress.

2.1 Participants

10 interviewees, included in internal project team for planning and procurement of intensive care unit with advanced medical technology equipment, suppliers, and healthcare professionals is planned for the data collection. The sample of participants will consist of key personnel involved in the design and procurement process. Also, a questionnaire will be given also to about 30 health care professionals affected by the procurement.

2.2 Materials

As a base for data collection is planned to use written instructions regarding procurement process, a semi-structured interview guide and a questionnaire based on the stepwise model (Jakobsson, Svenson & Salo, 2010). The HTO-model and stepwise model is planned to use as analytical tool for the data collected.

2.3 Procedure

The written instructions will be themetized against the theoretical models. Responses at interviews will be written down of the interviewers. Interview responses are integrated against written routines and theoretical models.

4. Ethical Questions

The participation in interviews and questionnaires will be voluntary. The interviewees will be given the opportunity to comment the text coming from the interviews. The participants will be given the possibility to get deeper information of the study and the study’s ‘result on request.
5. Expected Results

An expected result is that the stepwise procurement model and framework HTO may be combined and fruitful for the description of the procurement process. Expected results is also that the analysis tool (procurement model and HTO) for review of design and procurement process should lead to suggestions for improvement of design and procurement in areas such as future patient safety, future personnel work environment and system performance and thereby inter alia give base for health care givers in their work to develop procurement process.

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