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System Design Perspective of Healthcare Provision in Humanitarian Aid

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Abstract

This study focuses on the role of Systems Design in addressing the challenges of healthcare provision by international emergency relief organizations in developing countries. More specifically the challenges related with the safety and performance of medical devices that are transferred in the aftermath of a humanitarian crisis. Our aim is to describe this transfer on the basis of two field studies in Indonesia and Haiti and reflect on the value of Human Factors and Ergonomics for a Systems Design approach. The presented concepts support designers in handling a larger degree of complexity and support them to think more steps ahead in a design project. Future studies will involve collaborative design projects dedicated to bring this reflection further to the development of healthcare products and services.

Background

The present increase of frequency and complexity of humanitarian crises have a particularly strong and lasting impact in developing countries due to the susceptibility of multiple socio-economic variables to risks[1]. International emergency relief is a specialized field of humanitarian aid focused on short-term and life-saving interventions, aimed at the temporary reinforcement of systems (e.g. sanitation, healthcare) jeopardized or disrupted by e.g. a natural disaster or flee from conflict.

Healthcare services in humanitarian crises are essential for the affected population, but they are vulnerable as they are often not able to cope with the overload of patients and the limited infrastructure. The conditions of healthcare provision in humanitarian crises have been poorly explored regarding the safety and performance of medical devices that are transferred, together with medical staff to provide care in the affected country. After being used, the devices are most often donated to local entities. Although, there is limited information about the outcome of this one-sided transfer, there is evidence that about 50% of medical devices donated to developing countries lie idle in hospital rooms. Several explanations have been proposed, such as device inappropriateness to context or the lack of local expertise in use or maintenance[2-4].

A Systems Design approach

The suitability of medical devices and their use context can be analysed from a Socio-Technical Systems (STS) perspective. STS have their origins in work analysis within the field of organizational change and are defined by a complex configuration of defined institutional, socio-cultural, organizational and technological elements, arranged hierarchically in system levels to fulfil a determined social function (e.g. healthcare). Each element involves technical (tangible) and socio-political aspects (intangible). STS are further characterized by the interrelationship and mutual influence between system levels of which change is dependent on and that result in system properties, such as safety or sustainability[5,6].

More recently, STS have been adopted by the field of innovation and design allowing us to put the functionality or goal of the intended (entire) system in the focus of innovation rather than the specific needs of a single level. The model in Figure 1 is adapted from a descriptive model[7] that illustrates the hierarchy of system levels involved in the process of innovation of products and services.

Systems Design proposes that the successful implementation of a new product, service or policy, designed to take part in a specific STS depends on the functioning and interrelationship of the existing system levels. The system levels should, therefore, be considered in the design of a determined novelty to guarantee the realization of its intended function[7,8]. In this way, not only technical, but also organizational and social conditions in which the technology is used are considered. In fact, the more system levels are considered in the design approach, the greater the capacity of the system to address a certain function[6,9]. This means that redesigning the physical attributes of an existing medical device to improve safety of the healthcare system results in a smaller and shorter-term impact in the system than designing a coherent combination of processes and products to fulfil the same purpose[6,10,11,12].

The field of Human Factors and Ergonomics (HFE) offers adequate tools for collecting knowledge required by Systems Design given that it focuses on the "understanding of interactions among humans and other system elements of a *system"* by developing and applying "theory, principles, data and methods to design in order to optimize human well-being and overall system performance"[13]. Within the domain of medical device design, HFE plays an increasing role in supporting user-centred design through the systematic understanding and management of systemic risks with legal directives and guidelines in assuring healthcare systems to become safer[14].

Systemic transfer of medical devices

The particular challenge posed by international emergency relief (Figure 1) is that it implies a temporary transfer between two inherently different systems (x and y) with long-term effects (y'), rendering the available medical devices inadequate to function. This mismatch is the result from systemic factors that act as barriers for healthcare safety.

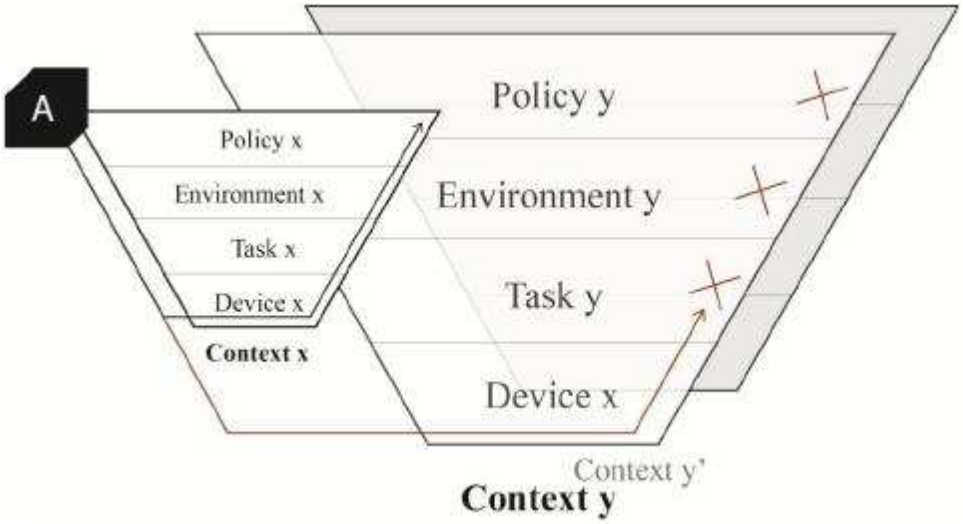

Figure *1*: Transfer of product A between contexts x, y and y'

For example, a pulse oximetry (device A) is considered an essential medical device in international emergency relief[15]. It is designed within and for an European context (context x), with consideration of existing safety regulations, operational healthcare facilities (e.g. sales department, sterilization, waste management), capacity to afford and maintain devices, task distribution and stable energy supply. When transferred to Haiti (context y) these devices will face several barriers across the system levels, which represent a threat to the functioning and safety of the overall system. The device needs to be packed and transported according to a determined logistical process (environment y) and it might face delays and restrictions at customs (policy y). The dependency on disposable components (probes) and batteries (device x) implies that these need to be inventoried and purchased. The lack of an inventory and purchasing system leads to their reuse. Often the probes will break faster and require repair that, for lack of tools or support, is replaced by a temporary fixing (device level). Batteries will also require a charger and are often over-reused due to the lack of a disposal system (environment y'). Even though several coping mechanisms are created to address these barriers, devices tend to malfunction and disrupt the nurses‟ workflow (task level)[16].

Discussion

HFE has the potential to address societal issues, such as environmental sustainability or global health and offers effective tools to support the design of safe and thorough user-centred systems. However, it generally focuses on adjusting product attributes to a determined environment, rather than taking more system levels into account[17,18]. An affordable and robust pulse oximetry for Haiti aims to promote rapid access to healthcare by rethinking physical attributes, such as materials and energy sources, which often create barriers. These new physical attributes will ultimately face challenges in the overall system. A Systems Design approach aims to rethink the use of local resources and the cost structures to formulate a strategic combination of services (alternative distribution channels) and products

(universal probes and repair tools) for transitional adoption of the device.

Systems thinking can enrich HFE and support designers in handling a larger degree of complexity, take the entire system into account and support them to think more steps ahead in a design project[11]. This allows designers to make a more sustainable change by considering a long-term timeframe and the involvement of a larger stakeholders‟ network. However some questions remain unanswered such as how should user-centred knowledge be used to support Systems Design?; and how does the shift in the design focus – from problem to system functionality – contribute to differentiate Systems Design from existing ineffective design efforts in developing countries?

Given that international humanitarian organizations become increasingly connected to industry and academia there are opportunities to explore the potential contribution of Systems Design to perform better aid.

Our ongoing research involved interviews with emergency relief experts and two field studies in disaster-prone countries, Indonesia and Haiti, during which, several systemic challenges have been identified. Future studies will be dedicated to explore the value and relation between Systems Design and HFE tools used in the design of products and services in collaboration with humanitarian stakeholders. These results will be available soon.

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