Contextualizing Effective Use of Health Information Systems in Humanitarian Setting: The role of Transparent Interaction

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ABSTRACT

Humanitarian organizations strive for efficient and effective interventions, with information systems playing a crucial role. However, integrating data collection and processes within their operations remains a challenge. This paper examines the effective use of a Health Management Information System in a humanitarian context. Effective use aims at helping information systems contribute to the organisational objectives and holds promises to help improving information systems in this domain. The analysis uncovers obstacles related to system access and learning processes, suggesting that transparent interaction is vital for success. Transparent interaction is the first dimension in the Theory of Effective Use. Through contextualization, this paper defines effective use in humanitarian settings and evaluates the theoretical model's validity in this unique context. Drawing from concepts from the information systems body of theory, it contributes to the understanding of effective use by offering a contextualized model and a clear definition of transparent interaction, emphasizing its significance.

Keywords

Effective Use, Humanitarian Health Information Systems, Transparent Interaction, Affordance Network.

INTRODUCTION

The past year has been marked by ongoing conflicts, severe climate issues, and health crises like cholera and COVID-19. These factors have led to an alarming rise in hunger, displacement, and poverty. As a result, it is estimated that 339 million people will require humanitarian assistance and protection. This is a significant increase from the 274 million people estimated at the start of 2022. In short, one out of every 23 people will be in need of humanitarian aid (OCHA, 2022). In response to such existing and increasing demand humanitarian organizations assist people and communities who are in need and face significant challenges. This includes refugees, asylum-seekers, internally displaced populations, and others who have been affected by diseases, conflicts, and both human-made and natural disasters. Humanitarian organizations need to ensure efficiency and efficacy in their interventions and are expected to share data effectively to provide more coordinated interventions, improve accountability and provide efficient response (Checchi et al., 2017). The use of digital technologies and information systems are an integral part of the deployment of the response provided (Hunt et al., 2016). They facilitate communication, coordination, and the collection and analysis of large amounts of data, enabling timely responses in humanitarian contexts (Mesmar et al., 2016).

Information systems are contributing to providing the required information, and operational improvements involve the use of project management information systems and digital technologies for data collection and analysis. This shift has been observed in many humanitarian organizations over the past decade (ALNAP, 2015), replacing outdated spreadsheets and paper-based systems. These changes are expected to increased efficiency and effectiveness in their interventions; however, organizations have not yet fully succeeded in integrating data

collection and integration processes within their operations (ALNAP, 2022). Field interventions are not heavily scrutinized form a public health perspective among humanitarian actors, however, public health data is fundamental for documenting processes and interventions and to reinforce accountability and advocacy, really important in the context (Jarrett et al., 2021). A recent study of the status of the humanitarian system on the evidence of monitoring and evaluation data from eight big humanitarian funders showed evidence of impact was only available for 16% of the projects (ALNAP, 2022), in most cases it was not possible to collect data on the outcomes after the funding ended. This reveals a significant data gap on what impact innovations are collectively having on humanitarian effectiveness and efficiency (ALNAP, 2022).

The role of Humanitarian Health Management Information Systems (H-HMIS) is to collect routine data from the field interventions and generate the indicators and data aggregations necessary to follow up the status of the intervention and population needs (Magnuson & Dixon, 2020). Routine health data provides crucial public health information, enabling real-time surveillance, monitoring systems, and guiding timely interventions. Additionally, it facilitates the evaluation of intervention and accountability towards the organization's mission and objectives (Checchi et al., 2017). Measuring impact in the wellbeing of the population might exceed the domain of information systems theories, however, having robust information systems is a key component for it. The theory for Effective Use holds promises to contribute to improving information systems in this domain by helping assess to what extent information systems are effectively contributing to the organisational objectives and provide instrumental guidance to organizations to strengthen their internal information systems and reporting mechanisms. With the aim of analysing the adequacy of the theory for the context of humanitarian organizations, this paper aims to answer the following research question:

What are the challenges for attaining effective use of a humanitarian health management information system?

In the empirical setting of a field intervention of Médecins Sans Frontières Spain (MSF Spain), this analysis builds upon previous research which has studied the implementation and adoption of a H-HMIS from the headquarters offices in the global context of the organization (Vila-Pozo & Sahay, 2018), to the project coordination office (Vila-Pozo & Sahay, 2019) and the inpatient wards in the field hospitals (Vila-Pozo et al., 2022) of one of its field interventions.

The core analysis is based on a contextualization of the theory for effective use. In the next section, the theoretical component of this analysis is introduced. The third section introduces the case study, followed by an analysis and findings. The paper concludes with the discussion of findings and theoretical contributions.

RELEVANT LITERATURE

Theory of Effective Use

The theory of effective use (TEU) draws from Representation Theory (RT) and the conception of information systems as semantic systems (Wand & Weber, 1995). Representation Theory conceptualizes systems as capable of representing phenomena from which individuals retrieve digital representations of the real world. Therefore, an information system conveys meaning through a structure of signs. Representation Theory posits that information systems are comprised of three interrelated structures:

- Deep structure: This refers to the definition of data structures and their specifications to represent the domain. In the case of the H-HMIS it refers to the database and data model definition.
- Surface structure: This is the structure that enables the user to access the deep structure. It would mainly be the user interface of the H-HMIS.
- Physical structure: This component connects the deep and surface structures. This is the hardware supporting the implementation, from the computers or mobile devices to the broader infrastructure.

Individuals use digital representations to gain knowledge about a particular situation from the real world that informs their actions (Burton-Jones et al., 2017). The transition from use to effective use can be seen as the evolution from looking at the mere use of the system to perform a specific task (system use) to its use in a manner that contributes to the attainment of the organizational desired goals (effective use). The use of the information system is not seen as a goal itself, but as a mean to an end, i.e., the organization's objectives. Effective use is defined as "using a system in a way that helps attain the goals for using the system" (Burton-Jones & Grange, 2013). The nature of effective use is modelled across the following three dimensions, as described by Burton-Jones and Granje (2013):

- Transparent interaction: refers to "the extent to which a user is accessing the system's representations unimpeded by its surface and physical structures".

- Representational fidelity: relates to "the extent to which a user is obtaining representations from the system that faithfully reflect the domain being represented".
- Informed action: refers to "the extent to which a user acts upon the faithful representations he or she obtains from the system to improve his or her state in the domain of work".

The relationship between these dimensions is hierarchical. As a hierarchical network, transparent interaction activates information potential, which enables representational fidelity. Representational fidelity can then be leveraged by informed action (Burton-Jones & Grange, 2013). Actualizing these three dimensions is crucial to achieve effective use, where each of them is necessary but not sufficient for the next. This relationship is visually represented in Figure 1 below.

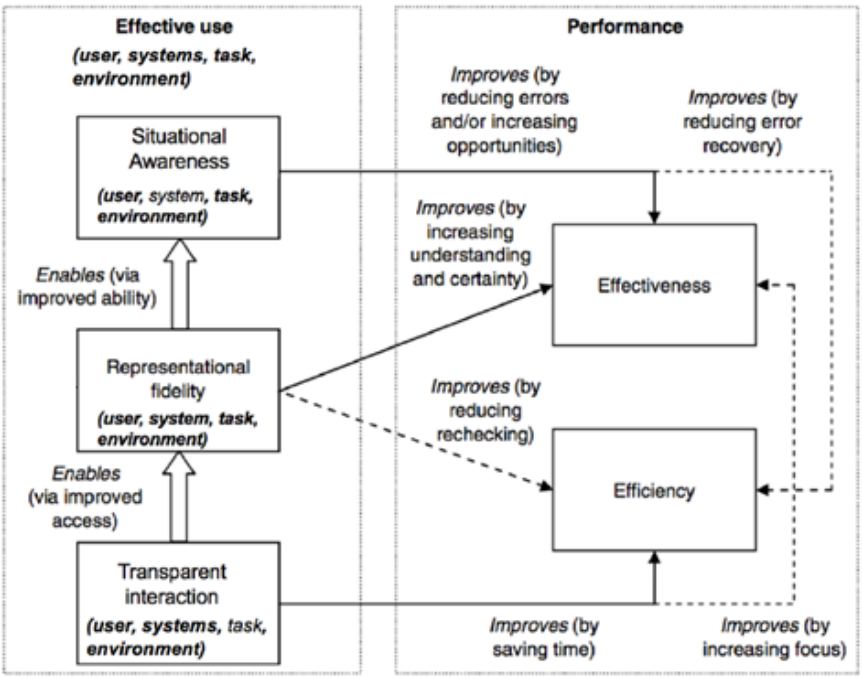

Figure 1. Effective Use model adapted for emergency management contexts (Bonaretti & Piccoli, 2018).

The theory of effective use has been used to guide research on IS implementations in a variety of domains, such as hospitals (Eden et al., 2018; Eden et al., 2019), educational providers (Eden et al., 2020), enterprises (Trieu, 2013), banking (Haake et al., 2018), and more recently in Emergency Management (Bonaretti & Piccoli, 2018) which proposed modifications to the TEU model. The main modification involved replacing the Informed Action dimension with Situational Awareness as the third dimension of effective use. Situational awareness assumes that all the necessary information may not be present in the information system (Endsley, 1995), and the focus instead is on sufficiency of the information as a foundation of effective use. The resulting TEU model adapted for emergency management contexts can be also found in Figure 1. When analysing the dimensions for effective use in this paper, I will use this model with situational awareness as the third dimension and the environment included as a function for effective use in addition to the user, the system, and the task, that are introduced in the original model. My application of the theory of effective use is based on its operationalization for the humanitarian field.

CASE ANALYSIS AND FINDINGS

Research Context

This work builds upon a longitudinal case study (2015-2021) examining the implementation and adoption of the H-HMIS across the whole organization. From the headquarters offices in the global context of the organization (Vila-Pozo & Sahay, 2018), to the project coordination offices (Vila-Pozo & Sahay, 2019) and further to inpatient wards in two field hospitals (Vila-Pozo et al., 2022) within one of its field projects deployed to providing health care in a camp for internal displaced populations.

The empirical setting of this analysis was the field mission of MSF Spain in South Sudan. South Sudan has been a consistent focus for MSF Spain since 2013, following the eruption of civil war shortly after the nation's 2011

independence. In the ensuing chaos, an estimated 400,000 lives were lost, 2.28 million individuals sought refuge in neighbouring countries, and another 1.87 million were displaced within South Sudan's borders (MSF Spain, 2021).

Analysis and Findings

This section presents a contextual analysis based on the conceptualization of the theory for effective use in a humanitarian setting. The approach follows a step-by-step recommendation from Burton-Jones and Volkoff (Burton-Jones & Volkoff, 2017) for developing contextualized theories of effective use which consists on:

1. Understanding how a network of affordances supports the achievement of organizational goals.
2. Understanding how the affordances are actualized.
3. Using inductive theorizing to elaborate those principles in a given context.

The theory of effective use, and this process for its contextualisation, govern the analytical framework guiding this research. This approach however, introduces and builds upon the concept of affordances (Strong et al., 2014) and network of affordances (Burton-Jones & Volkoff, 2017). Affordances are theoretically defined as "the potential for behaviours associated with achieving an immediate concrete outcome" (Strong et al., 2014, p. 69), and their actualization is the enactment of such potential in context. Affordances, hence, refer to the relation between the users and the system and their capacity to use it to support their everyday actions, in our case related to the use of the information system during a humanitarian intervention. In the interest of clarity and to align with the theoretical emphasis of this article on the theory of effective use, the term affordances will, in the context of this study, be substituted with *functionalities* and their related process of actualization or realization. Consequently, the network of affordances, will be designated as the network of functionalities facilitating the attainment of the organizational objectives. The following sections develop each of the three different phases enumerated above, using the proposed terminology.

Understanding how a Network of Functionalities Supports the Achievement of Organizational Goals.

The network of functionalities is built upon outcome-units, which represent the relationship between each functionality and its potential outcome (Burton-Jones & Volkoff, 2017). These outcome-units collectively contribute to the overall organizational objectives. By analysing the interconnections between functionalities, the network allows us to understand the interdependence, chronological sequence, and presence of functionalities and outcomes across different organizational levels. Taking together the functionalities and organizational objectives, the analysis helps to understand how the technology helps to meet the objectives of the organization, concerning the effective use of the system in the field project. As introduced above, prior research has identified the operating functionalities of an H-HMIS at the two field levels under study *i)* the project coordination office (Vila-Pozo & Sahay, 2019), and *ii)* the inpatient ward in the health facilities (Vila-Pozo et al., 2022).

Table 1 Operating Functionalities of H-HMIS in the field setting

Level	Functionality	Description
Project Coordination	Operationability	The possibility to use data to follow up trends and identify alerts for constant response and adaptation of activities.
	Contextuability	the possibility to know and analyse context when you are new to the intervention.
	Accountability	the possibility of data to be accountable for day-to-day activities and operational decisions.
Health Facility [1]	Collectability	The possibility to collect patient data along with the medical interventions.
	Aggregability	The possibility to aggregate data at the end of each reporting period.
	Manageability	The possibility to manage the hospital ward with the data collected.
	Recordability	The possibility to access patient historical records when they are readmitted.

[1] The functionalities at facility level were published with a different naming convention. Names have been adjusted to match the style of those identified at the project coordination level.

The organizational objectives to which the functionalities contribute to are those of:

Monitoring the quality of health services: this objective refers to the continued follow-up, assessment, and evaluation of the different aspects of the intervention related to the health services provided. The functionalities contributing to this objective are mainly those operating at the project coordination office. Operationability allows the tailoring of the services provided to the actual and changing needs. Accountability ensures following the organizational paths for mobilizing or relocating resources, and contextuability helps newcomers gain understanding of the situation when initiating their professional activity in context.

Minimizing data management workload of field workers: this objective aims at reducing the effort and time dedicated by field health staff to collect and process data. The functionality contributing principally and directly to this objective is that of Aggregability, since it eliminates the manual processes of aggregation and subsequent data entry, considered the most time consuming and prone to errors by field staff (Vila-Pozo & Sahay, 2019).

Reducing reporting and data integration delays: this objective aims at reducing the time span between data collection and its availability for integrated analysis at the higher levels in the organization. The functionality described as aggregability is again the main one contributing to this objective as it eliminates both, the manual process of aggregation and the data entry of the routine information into the H-HMIS. Once the data reaches the system, its integrated architecture guarantees data available at all levels at close to real-time without manual steps at the higher levels. Being data aggregation, data entry and data integration the main cause of delays in having managerial information, aggregability becomes the key functionality contributing to this objective.

Improving data use and informed decision-making: this objective aims at providing access to data and information and the right time to support operational decisions. From a coordination level, all three functionalities build the basis for informed decision-making for managing the intervention. At a lower level, manageability contributes to decision making at a lower level for the day-to-day logistics of the ward.

The network of functionalities

The representation of the network of functionalities presented below helps to illustrate the dependencies between functionalities and their contribution to achieving organizational goals. The diagram uses different colours to distinguish between facility-level (green) and project coordination-level (blue). The arrows between levels indicate the dependencies and follow the colour of the source level.

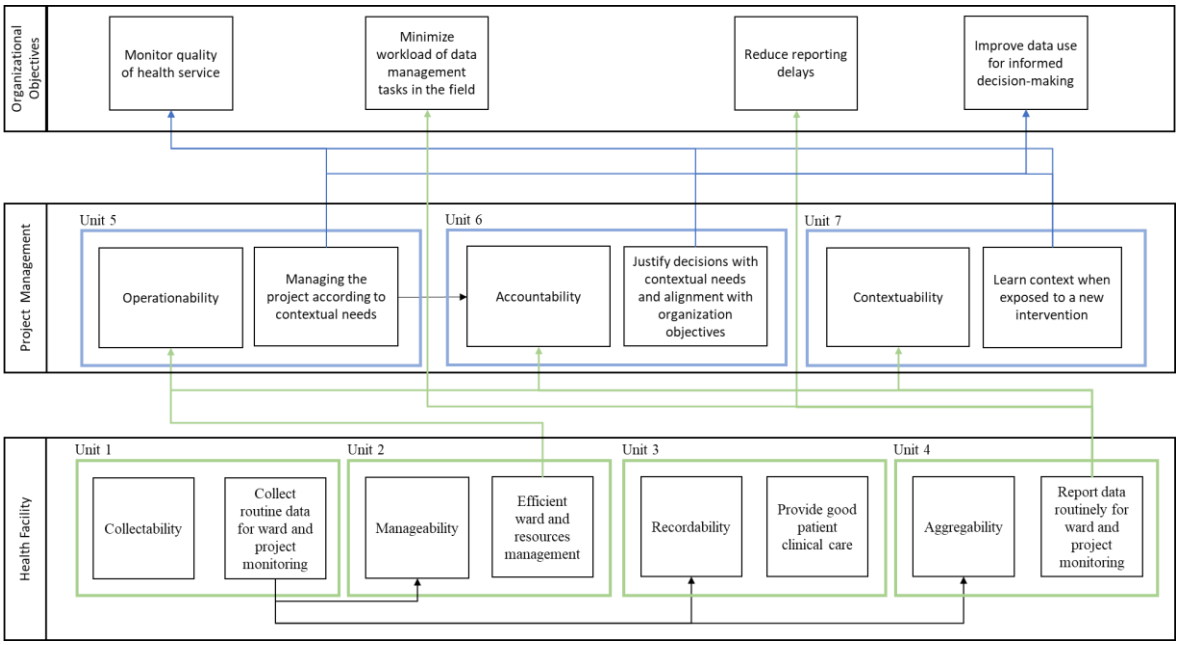

Figure 2. The network of functionalities.

This analysis focuses on the data collection process in a H-HMIS, from four different in-patient wards: adults, paediatrics, neonatology, and therapeutic feeding program, to the coordination office. In all these wards, patient data is collected daily through registration in a register book, where each patient is registered in one line with the basic information (Unit 1). This data serves as a basis for managing the ward (Unit 2), including the provision of food supplies, pharmacy stocks, bed linen, and bed nets, as well as accessing patient information for future readmissions (Unit 3). Additionally, at the end of each reporting period, data is aggregated on a weekly basis to

generate project monitoring reports (Unit 4). These outcome-units operate at the health facility level, they enable the functionalities at the next level and, in some cases (Unit 2 and 4), contribute directly to the organisational objectives of minimizing workload of data management in the field and reduce reporting times.

At the project coordination level, operationability is crucial to manage the evolution of the project according to contextual needs (Unit 5) and enables the functionality described as accountability (Unit 6). Contextuability allows new staff members to familiarize themselves with the specific work environment (Unit 7). The three functionalities contribute to the continued monitoring of quality of the health service and the improvement of data use for enabling informed decision-making.

Understanding how the Functionalities are Actualized

Building upon the network of functionalities as the path for effective use, the next analytical step is the study of the process of actualization for this setting and its work conditions.

To determine the potential impact of the context on achieving effective use, the next step involves analysing the operating conditions. The contextual characteristics operating in the deployment of an H-HMIS in a humanitarian setting respond to those of *dynamicity*, *restrictive infrastructure* that requires *independency*, and *heterogeneity* (Vila-Pozo & Sahay, 2018). Those contradict with the fundamental principles governing routine health information system: stability, infrastructural dependency, and homogeneity (Vila-Pozo & Sahay, 2018).

To better understand the impact of such contradictory principles on achieving effective use, it is necessary to analyse the operating contradictions at a lower level, specifically with respect to the core components of the information system: the deep, surface, and physical structure (Wand & Weber, 1995).

Deep structure: The H-HMIS evolves in a context where work routines tend to not facilitate the requirements gathering process, which potentially results in inadequate database and design configurations. In addition, the varied modes of operation through which humanitarian organizations must respond to different emergencies, such as armed conflicts, natural and man-made disasters, and epidemics raise different information needs. This requires a flexible data model which directly shapes the deep structure of the information system.

Surface structure: The context in which the system is implemented is also dynamic and the needs of the population evolve as the emergency unfolds. This creates a need for different data to be collected, and possibly from different new locations. The surface structure, consisting of the user interface, must be adaptable and able to absorb these changes to provide a meaningful user experience that facilitates data collection in multiple settings. In addition, there are severe infrastructure limitations that raise the need to support offline mode, data synchronization, and distributed systems, to manage the distributed data flows. The need to operate in independent and restricted settings can potentially affect the surface structures of the information system that needs to offer a flexible yet simple user experience.

Physical structure: The dynamic context explained above creates a need for different data to be collected from new locations. The physical structure may be affected due to the opening (and closing) of health units, with varying levels of access to Internet or electricity networks. This combined with environments with severe infrastructure restrictions where internet access, regular electricity supply, and where adequate workstations may not be readily available poses challenges on hardware and infrastructure. Deploying an information system that can function under such conditions directly affects the physical structure. The interplay between the system principles, the operating conditions and their impact on the system structures is represented in the figure below.

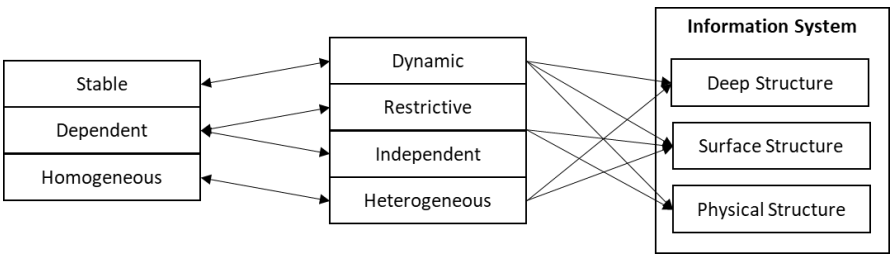

Figure 3. Conflicting logics and influence on system structures.

The environment, hence, affects all structures of the health information system, which in turn influence its implementation adoption and use. The operating conditions shape both, the features of the system as well as the interaction system-user. These characteristics of the humanitarian environment generate what I conceptualised as operating conditions. The operating conditions shape the actualization of the functionalities at their different levels of operation, sometimes as enablers sometimes as blockers for system use.

They have been identified as (Vila-Pozo & Sahay, 2019):

Mature use of information and positive perception of data was shown on day-to-day work practices. The field team relied on data to inform their meetings and decisions. Team leads encouraged collaborative analysis and events were discussed basing their arguments in the data available, when possible.

Limited available information refers to the cases where the configuration of the H-HMIS in terms of the health content available to collect and analyse was not flexible enough to cover needs of the field teams leaving out sometimes critical information, while including other aspects less relevant for the intervention.

Characteristics of the humanitarian work environment represented the biggest challenges. The work environment is intense, and the team works long hours- Staff is limited, and personal and professional spaces and times are often mixed. Turnover rates among field staff are high which adds complexity to the already challenging work atmosphere.

Technical features of the system at the infrastructure level, require having an offline server which operates as independently as possible from the internet connection and power supplies, which influences both the infrastructure and hardware as well as the user interface. At a functional level, the automatic integration of data in one central database was seen as useful for integrated analysis. The system, however, was perceived as adequate for data entry tasks, but having all data in one system was perceived as complicated by users accustomed to work on excel files for data analysis.

The impact of such operating conditions shapes the actualization of functionalities when the user interacts with the technology. At the project coordination office, the actualization process suffered interaction effects – enabling or constraining, which shaped the overall actualization of the functionalities (Vila-Pozo & Sahay, 2019). The limitations in information and the work environment where always constraining and negatively affecting the actualization of functionalities, as they imposed challenges at different levels, from data related limitations to human resources difficulties caused by a high turnover of staff, very common in these types of organizations.

Other operational conditions had dual effects. The mature use of data was perceived as fuel for system use is most cases, however, when combined with limitations in the information available, resulted in a motivation for using parallel tools and ad-hoc solutions, including does based on paper reporting. The technical features had similarly dual effects, a centralized integrated model introduced benefits like an increase in data quality, more comprehensive data analysis and an enhanced ownership of data at the lower levels in the field. It did require however a data model which was perceived as rigid to respond to dynamic needs and complex for data analysis in the field.

At the health facility level the actualization of functionalities was tightly coupled with an intuitive user experience that did not require training, and user motivation towards introducing the digital system in their day-to-day medical work was mainly based on the system providing such intuitive user experience and/or being explicitly useful for their daily responsibilities (Vila-Pozo et al., 2022). Under the operating conditions identified at the work-place in the humanitarian intervention, the way technology is perceived and more importantly, its perceived usefulness, influence how technology functionalities are realized. The analysis conducted in the study (Vila-Pozo et al., 2022) revealed that users consistently favoured technology solutions that were perceived as easy to use, requiring minimal training efforts and without any friction. However, this preference shifted when the technology demonstrated an immediate perception of usefulness, particularly through significant time savings in data management compared to traditional paper-based methods (Vila-Pozo et al., 2022).

Using Inductive Theorizing to Elaborate the Principles for Effective Use in the Context of Study

The main goal of the final step of this contextualization is to perform an analysis of the suitability of the theoretical model for effective use and its application in a humanitarian setting. To guide this analysis, I summarize the findings from the previous steps in three principles for effective use of information systems in humanitarian settings.

1. Humanitarian projects experience high turnover, and users work in hectic and autonomous environments. The completion of training tasks is challenging, and user adaptations may lead to system abandonment.
2. Humanitarian work develops in non-structured and fast-paced environments, an intuitive user experience is considered imperative to ensure use of the system.
3. Humanitarian workers have to juggle multiple priorities constantly, optimizing time and perceived usefulness are critical factors for effective system use within this context.

The theoretical model for effective use in an emergency environment is depicted in Figure 4 below.

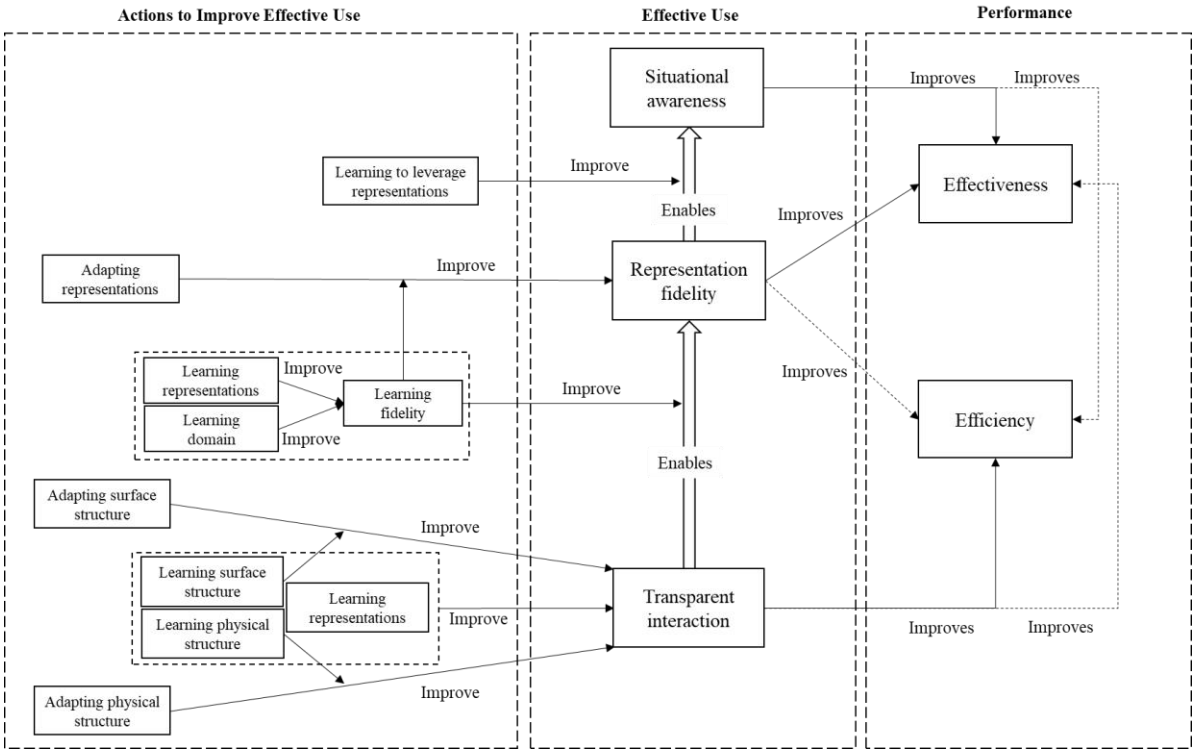

Figure 4. Representation of the TEU model (Burton-Jones & Grange, 2013) extended for emergency management (Bonaretti & Piccoli, 2018)

The image guides a discussion in which the fundamental principles of both the theory and the setting are assessed in combination. The analysis focuses on examining the dimensions for effective use, as defined in the original theory (Burton-Jones & Grange, 2013), which include transparent interaction, representational fidelity, and situational awareness (Bonaretti & Piccoli, 2018). The aim is to assess their suitability for the users and context of the H-HMIS, rather than customizing the dimensions specifically for this context, as suggested by the authors in their approach to contextualizing effective use (Burton-Jones & Volkoff, 2017) . The contextualisation approach taken in this study, hence, is based on the assessment of the nomological principles of the theory for effective use in contrast with the three principles for effective use in humanitarian settings derived from the previously presented findings.

The discussion will commence by understanding the relationship between the identified functionalities and the dimensions for effective use, followed by an assessment of the overall theoretical model in contrast with the three principles for effective use in humanitarian settings.

Effective Use through Effective Actualization

Situational awareness, as referenced in the literature (Endsley, 1995), is a precedent for informed action and is associated with understanding and comprehending the domain of work in context. This dimension plays a crucial role in enabling functionalities that involve decision-making at higher levels, including operationability, accountability, and contextuability in project coordination. Situational awareness is also relevant in tasks such as ward management and accessing patient data at the healthcare facilities. By enhancing the understanding of the situation, this dimension has the potential to enhance effectiveness and improve efficiency by helping guide the intervention providing information for informed decision-making, and minimizing the time required to rectify errors resulting from ill-informed decisions.

Representational fidelity refers to "the extent to which a user is obtaining representations from the system that faithfully reflect the domain being represented" (Burton-Jones & Grange, 2013). This dimension enhances effectiveness by facilitating users' comprehension of their domain and reducing uncertainty. And improves efficiency by reducing the time required to verify information that is mistrusted by the user. Representational fidelity enables situational awareness, thereby contributing to the functionalities associated with decision-making. In the context of this case study, it will also impact the functionality of collectability, as the limitations on available health related information in the system configuration can pose challenges to data collection when does not reflect properly the contextual needs. It will also influence the functionality of aggregability, as the subsequent

representations generated for data analysis are based on the periodically aggregated information.

Transparent interaction refers to "the extent to which a user is accessing the system's representations unimpeded by its surface and physical structures" (Burton-Jones & Grange, 2013). This dimension contributes to efficiency primarily by reducing the time users allocate to interacting with the system. Also, the system's capacity to provision useful representations can facilitate more seamless interactions, which, in turn, can enhance user focus—a crucial factor for efficacy. This dimension is about system access. As such, it holds the initial position within the hierarchical construct of effective use, being placed at the point direct interaction occurs between the user and the technology. When analyzing technology use in the setting under study, the key conditions for the actualization of the functionalities required a seamless experience of system use and a direct perception of usefulness of the system as pivotal conditions for realizing the functionalities that support users' operational tasks.

The Model of Effective Use in the Humanitarian Environment

Actions to Improve Effective Use

The theoretical model suggests that users can do certain actions to improve how effectively they use the system. There are two types of actions: adaptation and learning. Learning actions are those taken to learn the system, the domain it represents or its representations. Adaptation actions are those made to improve the system representations or the access to them. According to the model (shown in Figure 4. Representation of the TEU model (Burton-Jones & Grange, 2013) extended for emergency management (Bonaretti & Piccoli, 2018)), these actions aim to improve the different dimensions of effective use, transparent interaction, representational fidelity, and situational awareness. They aim however more prominently at improving transparent interaction, which has a primary role on the dimension ladder (Burton-Jones & Grange, 2013).

When analysing the drivers for effective use, the first of the three principles for effective us in humanitarian contexts contrasts with the theory of effective use in the perception of the role of learning and adaptations. The theory of effective use positions learnings and adaptations as the mechanisms for improving the dimensions for effective use, while the first principle for effective use of information systems in humanitarian settings position these actions as a challenge and barrier to system action based on work environment and high turnover rates: "1. Humanitarian projects experience high turnover and users work in hectic and autonomous environments. The completion of training tasks is challenging, and user adaptations may lead to the abandonment of the system".

This arguably constitutes a limitation in the applicability of EUT for humanitarian settings.

The Dimensions of Effective Use

Situational awareness is the dimensions which operates farther from the system-user interaction, as it is enacted through the processing of the information retrieved from the system to gain knowledge about a particular situation or aspect of a domain. In this sense, the principles for effective use in humanitarian settings do not question this construct, the opposite, they define the conditions the system should offer at the precedent dimensions to guarantee that users can attain situational awareness.

Representational fidelity. As stated in the third principle for effective use of information systems in humanitarian settings: "3. Humanitarian workers have to juggle multiple priorities constantly, optimizing time and perceived usefulness are critical factors for effective system use within this context". Meaning that users need to perceive that the system is useful. The representations provided play a key role in providing such experience as they need to inform about the situation the user is traying to understand and analyse is a simple way. Users need to read and process information in an agile and intuitive manner. If having good understanding of the representation requires training or adaptations, the system would be challenging the first principle, which state that "3.… the completion of training tasks is challenging, and user adaptations may lead to system abandonment and an intuitive user experience is considered imperative to ensure use of the system".

Transparent interaction addresses system access as it is the "port of entry" for the interaction user-technology. The three principles for effective use pose challenges to this dimension, as it is a that level where the humanitarian setting imposes more restrictions. The more explicit mention to system action and user interaction is on the second principle which states that "2.…an intuitive user experience is considered imperative to ensure use of the system". This couples with a need to minimize training, ideally system use would not require a cognitive process or explicit training because, according to principle "… the completion of training tasks is challenging" and would not require user adaptations as humanitarian workers operate in a very decentralized and autonomous way and "…user adaptations may lead to system abandonment". The last principle puts even more conditions to the user experience

as it adds a requirement of perceived usefulness. In an environment where "…workers have to juggle multiple priorities constantly", and the system must compete with other duties the perception of usefulness is a critical factor for effective system use.

Performance

The dimensions of effective use are necessary for improving performance through both effectiveness, which refers to "the extent to which a user has attained the goals of the task for which the system was used", and efficiency, which relates to "the extent of goal attainment for a given input" (Burton-Jones & Grange, 2013). Performance is addressed from all the three principles for effective use in a humanitarian context but is the key focus of the third one stating that "3. Humanitarian workers need to constantly juggle priorities, optimizing time (efficiency) and ensuring perceived usefulness (efficacy) are critical factors for effective system use within this context."

In summary, the conceptualization of the dimensions for effective use as a hierarchical mechanism towards improving performance, aligns well with the contextual analysis of the H-HMIS and the individual functionalities identified in this contextualization. The analysis highlights, however, two main aspects where the theoretical model and principles might arguably not be directly applicable. Firstly, relying on user's actions, such as training and adaptation, to improve effective use is arguably not appropriate for the humanitarian context, and secondly, transparent interaction holds the majority of the challenges imposed by the context while being a determinant in system use and adoption of the H-HMIS under the conditions of the humanitarian environment.

These results raise an evident concern, humanitarian organisations need to improve transparent interaction while reducing the need for training and drastic adaptations. This builds the foundation to answer the research question which is addressed and discussed in the next section.

DISCUSSION

The contextualization of effective use in the case of a H-HMIS in a field intervention has provided the basis to answer the research question posed in this research *What are the challenges for attaining effective use of a humanitarian health management information system?*

In conclusion, the analysis and findings can be presented around two main aspects of effective use:

i) Transparent interaction is an essential dimension for effective use in humanitarian settings, being a major determinant in system use and adoption.
ii) Relying on user's actions (such as training and adaptation) to improve effective use through its dimensions, is arguably not appropriate for the humanitarian context.

These results position the challenges for attaining effective use of a humanitarian health management information system at the level of system access, with special emphasis in user experience and training actions as the main challenges for effective use is such work conditions. The role of transparent interaction is fundamental to address these concerns, hence this discussion will focus on understanding the construct and its application in the setting of study.

The Role of Transparent Interaction in Humanitarian Settings

The user experience of an H-HMIS needs to be extremely intuitive and provide a feeling of usefulness. In addition, due to contextual conditions, to complement an adequate level of transparent interaction, organizations need to minimize the need of training and adaptations. The main challenge to effective use is providing a maximized transparent interaction. This strong dependency leads to the refinement of the original definition in order to develop one that accounts for the particularities of the humanitarian setting.

Transparent is the adjective that describes the qualities of the user system interaction. To refine the concept of transparent interaction, I will start by focusing on its etymological meaning, *Transparent*[2] means "*Having the property of transmitting light, so as to render bodies lying beyond completely visible; that can be seen through; diaphanous*". In figurative terms "*Easily seen through, recognized, understood, or detected; manifest, evident, obvious, clear*".

When applied to information system, this can be interpreted as the ability of the system to let the usefulness (as the light does in surfaces) pass through its structures. When this happens, the potential actions offered to the user

[2] Oxford English Dictionary

are perceivable in an intuitive manner. Users would see that they can perform certain tasks, for example, registering a patient, by looking at the user interface and interpreting its labels and menus. And that action will be important for them and contribute to their day-to-day tasks to a level that dedicating time to it compensates the required dedication of time and effort. This understanding of the interaction aligns the original definition of affordances as "the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1979). The conceptualization of affordances assumes no need of an explicit cognitive process for the animal to actualize the affordance, affordances are perceived. While the concept of affordances remains at the theoretical underpinning of this research, the interaction of the user and the technology has been referred to as functionalities in this work. Hence, in the context of this article, this would be described as the intuitive perception and use of a functionality of the technology.

Winograd and Flores (Winograd & Flores, 1986) described readiness-to-hand as a very similar experience. They introduced it when describing transparent interaction in the domain of user experience and inspired the authors of the theory of effective use to propose the term *transparent interaction* as the first dimension (Burton-Jones & Grange, 2013). Readiness-to-hand emphasizes that users know the ultimate goal they want to achieve, such as driving a car, rather than the specific details of how to accomplish it, like determining the precise angle to turn the steering wheel. It highlights the user's perception of the possible actions involved (Winograd & Flores, 1986). This user experience relies on providing "the right coupling between the user and the action s/he wants to perform in the relevant domain" (Winograd & Flores, 1986). The domain refers to the reality in which the user develops its professional activities, and the key mechanism to coupling the system and the domain relies on the system´s ontology (Winograd & Flores, 1986). This emphasizes the importance of designing a system that uses a language which aligns with the environment where it is used. This is particularly relevant for humanitarian interventions which develop a specific vocabulary sometimes based on operational terms or specific acronyms.

The original term "Transparent Interaction" is described in the EUT model as: the extent to which a user is accessing the system's representations not impeded by its surface and physical structures (Burton-Jones & Grange, 2013). Based on this analysis, this paper proposes to expand the definition of transparent interaction in two aspects: the system structures influencing transparent interaction and the understanding of what does it entail to impede system access.

In relation to the system structures, the definition of transparent interaction explicitly mentions the access through the surface and physical structures, not including the deep structure. The analysis of the operating conditions, however, revealed the deep structure as a fundamental influence in the final user experience. In some systems the deep structure defines the ontology of the system which shapes the surface structure. The available data points or variables shaping the analysis are defined at the deep structure and can impose limitations which come from the inner data model which and cannot be overcome by a user interface. The adequacy of the system definition with the domain of work is of utmost importance and an inadequate configuration can lead to low understanding of the system and a weakened sense of usefulness. The importance of the deep structure in creating the basis for an appropriate domain for the user is key for providing an intuitive and "transparent" interaction. The first modification proposed to the definition of Transparent interaction is to make it inclusive to the three levels of the information system structures.

In relation to system access, the proposed definition mentions "impeded access" but is not explicit about how access can be impeded, or what constitutes unimpeded access. Findings from previous research showed that functionalities offering natural interaction with the system and perceived intuitively were more likely to be actualized over other ones which required learning or bigger efforts (Vila-Pozo et al., 2022; Vila-Pozo & Sahay, 2019). If we combine that user experience with the fact that learning actions are not an adequate driver for effective use, then the need of learning itself becomes an impediment to both the intuitiveness and the perception of usefulness for specific goals.

Both, Gibson in its original definition of affordances, and Winograd and Flores in their understanding of readiness-to-use, point to the same type of friction-free experience required for actualizing functionalities in humanitarian settings. And bringing back the etymological meaning of transparency as the transparent material "allowing light to pass through so that objects behind can be distinctly seen", this work proposes that transparent interaction is attained when the structures provide an extremely natural level of access in which the user can "see through" the system structures and perceive the required actions to attain a goal and its potential usefulness.

With these two considerations in mind, the proposed definition for transparent interaction is:

> *Transparent interaction*: the extent to which a user is accessing the system's representations in a way that its potential use is perceived through a surface, physical and deep structures.

This definition builds upon three qualitative field studies which scrutinized the organizational environment, the

functionalities, and their process of actualization of the H-HMIS in a humanitarian setting.

The definition and analysis of the concept of transparent interaction encapsulates two key aspects of the dimension: *(i)* the level of training required to use the system and *(ii)* the alignment between the system's ontology and the domain in which the user operates. Both aspects could be relevant in building measurement instruments for evaluating transparent interaction.

CONTRIBUTIONS AND FUTURE WORK

The contextualization of the theory of effective use in the humanitarian setting is accomplished through three means. Firstly, it involves studying the micro network of functionalities enabling effective use in the field settings. Secondly, it entails studying the micro-level process of actualization when situated in context. Lastly, it concludes by revisiting the dimension of transparent interaction and proposing two specific aspects for improving its measurement.

From a theoretical perspective, the analytical work contributes the theory of effective use by contextualizing and testing the theoretical model in the novel domain of humanitarian interventions, leading to the development of an empirically based definition of transparent interaction. Findings of this research identify learning and adaptations as a barrier for system use, and the development of the new definition for transparent interaction points out that coupling the system with the domain through an adequate and specific ontology is an integral mechanism for enhancing the transparency of surface, physical, and deep structures to the user and reducing the need of training. Practically, this work aims at providing practitioners and researcher new paths for studying and strengthening health information systems in humanitarian field settings. The proposed definition can be instrumental for helping practitioners assess the level of transparent interaction of their systems identified as they key challenge for attaining effective use.

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REFERENCES

ALNAP. (2015). *The State of The Humanitarian System*. A. Study.

ALNAP. (2022). *The State of The Humanitarian System*. A. Study.

Bonaretti, D., & Piccoli, G. (2018). Effective Use of Information Systems in Emergency Management: A Representation Theory Perspective. International Conference on Information Systems (ICIS 2018), San Francisco, CA, USA.

Burton-Jones, A., & Grange, C. (2013). From Use to Effective Use: A Representation Theory Perspective. *Information Systems Research*, *24*(3), 632-658. https://doi.org/10.1287/isre.1120.0444

Burton-Jones, A., Recker, J., Indulska, M., Green, P., & Weber, R. (2017). Assessing Representation Theory with a Framework for Pursuing Success and Failure. *MIS Quarterly*, *41*(4), 1307-1334. https://doi.org/10.25300/MISQ/2017/41.4.13

Burton-Jones, A., & Volkoff, O. (2017). How Can We Develop Contextualized Theories of Effective Use? A Demonstration in the Context of Community-Care Electronic Health Records. *Information Systems Research*, *28*(3), 468-489. https://doi.org/10.1287/isre.2017.0702

Checchi, F., Warsame, A., Treacy-Wong, V., Polonsky, J., Ommeren, M., & Prudhon, C. (2017). Public health information in crisis-affected populations: A review of methods and their use for advocacy and action. *The Lancet*, *390*(10109), 2297-2313. https://doi.org/10.1016/S0140-6736(17)30702-X

Eden, R., Akhlaghpour, S., Staib, A., & Sullivan, C. B.-J., Andrew. (2018). Unpacking the Complexity of Consistency: Insights from a Grounded Theory Study of the Effective Use of Electronic Medical Records. Hawaii International Conference on System Sciences, Hawaii.

Eden, R., Burton-Jones, A., & Donovan, R. (2019). Testing the Links from Fit to Effective Use to Impact: A Digital Hospital Case. International Conference on Information Systems (ICIS 2019), Munich, Germany.

Eden, R., Fielt, E., & Murphy, G. (2020). Advancing the Theory of Effective Use through Operationalization. European Conference on Information Systems (ECIS 2020), Virtual.

Endsley, M. (1995). Toward a Theory of Situation Awareness in Dynamic Systems. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *37*(1), 32-64. https://doi.org/10.1518/001872095779049543

Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Houghton Mifflin.

Hunt, M., Pringle, J., Christen, M., Eckenwiler, L., Schwartz, L., & Davé, A. (2016). Ethics of emergent information and communication technology applications in humanitarian medical assistance. *International Health*, *8*(4), 239-245.

Haake, P. S., Silvia, Mueller, B., Lauterbach, J., & Maedche, A. (2018). Toward an Operationalization of Effective Use. European Conference on Information Systems (ECIS 2016), Portsmouth, United Kingdom.

Jarrett, P., Fozdar, Y., Abdelmagid, N., & Checchi, F. (2021). Healthcare governance during humanitarian responses: a survey of current practice among international humanitarian actors. *Conflict and Health*, *15*(1). https://doi.org/10.1186/s13031-021-00355-8

Magnuson, J. A., & Dixon, B. (2020). *Public Health Informatics and Information Systems*. Spinger Nature. https://doi.org/10.1007/978-3-030-41215-9

Mesmar, S., Talhouk, R., Akik, C., Olivier, P., Elhajj, I. H., Elbassuoni, S., Armoush, S., Kalot, J., Balaam, M., Germani, A., & Ghattas, H. (2016). The impact of digital technology on health of populations affected by humanitarian crises: Recent innovations and current gaps. *Journal of Public Health Policy*, *37*(Suppl 2), 167-200. https://doi.org/10.1057/s41271-016-0040-1

MSF Spain. (2021). *Informe de Operaciones*.

OCHA, U. (2022). *Global Humanitarian Overview 2023* (9210024133).

Strong, D. M., Volkoff, O., Johnson, S. A., Pelletier, L. R., tulu, B., Bar-On, I., Trudel, J., & Garber, L. (2014). A Theory of Organization-EHR Affordance Actualization. *Journal of the Association for Information Systems*, *15*(2), 53-85.

Trieu, V.-H. (2013, 01/01). Extending the theory of effective use: The impact of enterprise architecture maturity stages on the effective use of business intelligence systems. International Conference on Information Systems (ICIS 2013), Milan, Italy.

Vila-Pozo, M. M., Martinez, R., & Sahay, S. (2022). Competing Affordance Potencies Shaping Data Collection: Case of Humanitarian Organizations. International Conference on Information Systems (ICIS 2022), Copenhagen, Denmark.

Vila-Pozo, M. M., & Sahay, S. (2018). Humanitarian Health Information Systems: Different challenges and responses. European Conference on Information Systems (ECIS 2018), Portsmouth, England.

Vila-Pozo, M. M., & Sahay, S. (2019). Institutional shaping of affordances: Implications on information use in global humanitarian organizations. International Conference on Social Implications of Computers in Developing Countries (IFIP 9.4), Dar es Salaam, Tanzania.

Wand, Y., & Weber, R. (1995). On the deep structure of information systems. *Information Systems Journal*, *5*(3), 203-223.

Winograd, T., & Flores, F. (1986). *Understanding Computers and Cognition: A New Foundation for Design*. Intellect Books.